

Draft Facilities Plan/Program
Proposed Sludge Management Program for the
Los Angeles/Orange County Metropolitan Area

Los Angeles-Orange County Metropolitan Area
Project, Whittier, CA

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**PROPOSED SLUDGE MANAGEMENT PROGRAM FOR THE
LOS ANGELES/ORANGE COUNTY METROPOLITAN AREA**

DRAFT FACILITIES PLAN/PROGRAM



LA/OMA PROJECT

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Analysis of ocean disposal systems, other than for the NEPA-CEQA No Project Alternative is not permitted under EPA and SWRCB policy. Accordingly, the funding for deep ocean outfalls and barge disposal was totally provided by the Los Angeles County Sanitation Districts, Orange County Sanitation Districts, City of Los Angeles.

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FOREWORD

Like other large urban communities the Los Angeles/Orange County Metropolitan Area has confronted the problems associated with management of the residuals produced from treatment of wastewater -- sludge. Population growth, requirements for improved treatment, and preclusion of ocean discharge are significant factors affecting choices among alternatives. Simply stated, the problem is that substantial amounts of wastewater solids (about half of the total for all of California) produced by the industries and people living in the Metropolitan Area must be managed efficiently and economically in an environmentally responsible and socially acceptable manner.

This report is a culmination of efforts which began in late 1974, with the execution of a Joint Powers Agreement among the City of Los Angeles, Los Angeles County Sanitation Districts, and Orange County Sanitation Districts -- the agencies responsible for sludge management in the Metropolitan Area. Region IX of the U.S. Environmental Protection Agency and the California State Water Resources Control Board, together with the three operating agencies, have provided continuing policy guidance for the Project through a five member Policy Board. Work began in 1975 with preparation of a work plan and has resulted in the development of a proposed management program and this environmental impact statement/report for the proposed facilities.

This Facilities Plan Report discusses in detail the development of the sludge management facilities proposed for each agency to accomodate sludge loads projected to the year 2000. Policy actions, continuing research needs, and implementation schedules are also specified. An accompanying report, the Draft Environmental Impact Statement/Report (DEIS/DEIR), discusses the assessment of management alternatives for the Los Angeles/Orange County Metropolitan Area, and describes the environmental consequences of the proposed sludge management program which centers on recovery of resources from sludge and involves energy recovery, composting and landfilling as specific processes. After completion of the public hearing and review process a third document will be prepared which reports the comments received and provides responses to such comments.

Upon EPA approval of the proposed management program and required environmental documents, each operating agency will initiate design of facilities set forth by the proposed management program. With EPA approval, the management program will also become a part of the Areawide Waste Treatment Management Plan (208 Plan) for the South Coast Area of California.

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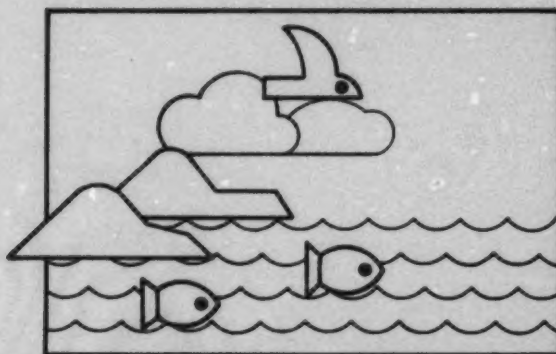
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APPENDIX B: SLUDGE MANAGEMENT ALTERNATIVE REPORT TOOL (SMART)

APPENDIX C: PROCESS FLOW DIAGRAMS FUNDAMENTAL SLUDGE MANAGEMENT ALTERNATIVES

CHAPTER I

CHAPTER I**BACKGROUND AND
PROBLEM DESCRIPTION****CHAPTER II****DEVELOPMENT OF THE
ALTERNATIVE SLUDGE
MANAGEMENT PROJECTS****CHAPTER III****DESCRIPTION OF THE
ALTERNATIVE SLUDGE
MANAGEMENT PROJECTS****CHAPTER IV****COMPARATIVE EVALUATION
OF THE SLUDGE
MANAGEMENT PROJECTS****CHAPTER V****DESCRIPTION OF THE
PROPOSED SLUDGE
MANAGEMENT PROGRAM****CHAPTER VI****DETAILED PHASE II
FACILITY DESCRIPTIONS****CHAPTER VII****ANALYSIS OF KEY TOPICS****APPENDICES****CHAPTER I****BACKGROUND AND PROBLEM
DESCRIPTION**

- PURPOSE, NEED AND EXISTING PRACTICES
- SLUDGE LOADS AND CHARACTERISTICS
- DEVELOPMENT OF THE SLUDGE MANAGEMENT PROGRAM
- REFERENCES

BACKGROUND AND PROBLEM DESCRIPTION

Sewage sludge is an inescapable consequence of a large urban society served by centralized wastewater treatment facilities. People and industries depend upon the wastewater system to remove sewage wastes from their immediate presence and to provide proper treatment for safe disposal in the environment. Sludge is a byproduct of meeting this need -- the cleaner the water, the more sludge is created.

Sewage contains solid particles, most of which are removed by wastewater treatment. Sludge is the broad term for the semi-solid mass formed from these particles during wastewater treatment. Undigested (raw) sludge contains more than 95 percent water, has an offensive odor, does not dewater readily, and has a high concentration of bacteria. Solid matter in sludge is mostly biodegradable organic material such as proteins, carbohydrates, fats, oils, and greases. However, other substances, such as heavy metals and trace organics may also be present, especially in large urban systems.

The goal of sludge management is to process undigested sludges so that the processed sludge will be acceptable for reuse or disposal in the environment. To this end, sludge management objectives should include (1) stabilization of organic matter to reduce nuisance potential, (2) destruction of pathogenic organisms as necessary to provide public health protection, (3) control of sludge moisture to meet processing needs and consumer and regulatory requirements for reuse and disposal, and (4) control of discharge of toxic substances to the sewerage system so that sludge quality is suitable for the selected reuse or disposal programs.

While all of these objectives are important, differing reuse and disposal options may require varying emphasis on individual objectives.

In our society, sludge has traditionally been treated and disposed of in the most economical and convenient manner. Since the cost of sludge management may amount to as much as one-half of the operating cost of wastewater treatment systems, wastewater management agencies have a keen financial interest in finding ways to manage sludge in a socially, environmentally and economically acceptable manner. Converging forces -- greater environmental awareness, escalating costs, federal and state environmental legislation and increased emphasis on resource recovery -- necessitate reexamination of sludge management programs. Alternatives must be found which are acceptable not only to the jurisdictions served by the wastewater agencies, but also to affected neighboring jurisdictions, regulatory agencies, and the public.

**PURPOSE, NEED
AND EXISTING PRACTICES**

PURPOSE, NEED AND
EXISTING PRACTICES

Sludge management in the Los Angeles/Orange County Metropolitan Area (LA/OMA) is the responsibility of the City of Los Angeles (CLA), County Sanitation Districts of Los Angeles County (LACSD), and County Sanitation Districts of Orange County (OCSD). Together, these three operating agencies treat approximately 1,000,000,000 gallons per day of wastewater produced by the some 8,000,000 persons living in the metropolitan area. In all, the LA/OMA area accounts for about half of the sludge produced in the state of California.

The Federal Water Pollution Control Act requires secondary treatment of wastewater prior to discharge to surface waters. The Act provides, however, for waiver of such requirements for marine discharges upon compliance with certain specified criteria. Each of the LA/OMA operating agencies is operating or has under construction facilities for secondary treatment of wastewaters by the activated sludge process and is awaiting action by EPA on waiver of secondary treatment requirements.

Two types of sludges must be managed by the operating agencies. Primary sludges are produced by quiescent settling of heavy solid particulates during primary treatment. Sludges produced by secondary treatment (activated sludge process) are biological in nature. Of the two types, secondary sludges are more difficult to manage principally because of poor moisture removal (dewatering) characteristics.

In the LA/OMA area, substantial commitment has previously been made to use of anaerobic digestion for conversion of about half of the organic matter to digester gas (about 60 percent methane and 40 percent carbon dioxide) and for destruction of all but the very resistant pathogenic organisms. Digestion does not affect water content, hence digested sludge is over 95 percent water and dewatering is required prior to subsequent handling on land. Industrial pretreatment and source control programs are also being used to control discharge of toxic substances to the LA/OMA sewerage systems. It may, however, be necessary to increase such efforts to meet sludge management needs and Federal requirements.

In 1976 (the first year of this study), the LA/OMA operating agencies collectively received and processed about 900 dry tons per day (dtpd) of raw sludge. By year 2000, the amount of raw sludge to be processed is projected to increase by 87 percent if full secondary treatment is provided for all wastewaters. While some of the increase results from population growth, the bulk of the increase results from secondary treatment. Currently, waste activated sludge is being generated by OCSD (approximately 30 dtpd) and by CLA (about 56 dtpd). By 1981, waste activated sludge will also be produced at the Joint Water Pollution Control Plant by LACSD.

In the past, LA/OMA operating agencies discharged screened, anaerobically digested primary sludge to the Pacific Ocean via submarine outfall systems. The same concern for environmental consequences that led to Federal and State requirements precluding this practice also led to steps taken by LACSD and OCSD to end sludge discharge. Beginning in 1968, LACSD added mechanical dewatering; then, by intensifying their land-based sludge handling operation in 1977 the agency

succeeded in digesting, composting, recycling and landfilling 530 dry tons of raw sludge per day. Similarly, OCS&D has been handling their sludge in land-based modes since 1971. Approximately 175 dry tons per day is removed from OCS&D effluent. Each of the operating agencies are currently pursuing interim management programs until the long term plan developed by LA/OMA Project is implemented. Secondary treatment facilities are now coming online and will be used in increasing amounts in the coming years. Increasing amounts of secondary sludges pose potentially severe problems for interim management programs which are being developed by the individual operating agencies. Each of the operating agencies' wastewater treatment plants is located in an urbanized area and concern for nuisance potential is high. Vacant land at the wastewater treatment plants exists in limited amounts and is diminishing as secondary treatment facilities are constructed. These conditions bring about the need for a long term sludge management program. In summary, the sludge must be managed in ways which:

- Comply with the State and Federal prohibition of sludge discharge to the ocean
- Comply with restrictions imposed by other regulatory agencies for protection of other environmental components
- Are considerate of the neighborhood and community concerns associated with siting of facilities
- Recognize technological uncertainties associated with management alternatives

Since sludge management costs may amount to as much as half of the operating cost of the wastewater systems, there is a keen financial interest involved. However, solutions must be found which consider not only the jurisdictions served by the wastewater agencies, but also the affected neighborhoods, regulatory requirements, and the public.

The wastewater treatment systems managed by the three operating agencies are large regionalized systems with the bulk of the wastewater processed at three large treatment complexes located near the Pacific Ocean. Sludge processing is largely confined to these three complexes.

CITY OF LOS ANGELES (CLA)

Organized as a charter city, the City of Los Angeles provides sewerage service to approximately 600 square miles, which includes most of the City of Los Angeles. Several other cities and agencies are provided service through contractual arrangements.

The major wastewater treatment complex is the Hyperion Treatment Plant. The City also operates the Los Angeles-Glendale Water Reclamation Plant located near Griffith Park and the Terminal Island Treatment Plant located on Terminal Island in the Los Angeles Harbor Area. Efforts have been underway for several years to construct the Sepulveda Water Reclamation Plant in the San Fernando Valley. Sludge from the Los Angeles-Glendale Water Reclamation Plant, and the Sepulveda Water Reclamation Plant, when constructed, is returned to the trunk

sewers for treatment at Hyperion. At the Terminal Island facility, sludge is processed on site. Long term plans for sludge management at Terminal Island are being developed by the City of Los Angeles.

Hyperion Treatment Plant (HTP)

Hyperion is located on a 144 acre site adjacent to the Pacific Ocean at the intersection of Imperial Highway and Vista Del Mar. The rated capacity of the wastewater treatment plant is 420 million gallons per day (MGD) of primary treatment and 100 MGD of secondary treatment. In 1978, the reported influent flow was about 345 MGD.

Primary treatment at Hyperion consists of screening, grit removal, and sedimentation. Secondary treatment is accomplished by means of the conventional activated sludge process followed by sedimentation. Currently, all wastewater receives primary treatment, and about one third of the primary treated wastewater receives secondary treatment. Grit, screenings, and digester cleanings are hauled to Palos Verdes landfill. Treated effluent is discharged to Santa Monica Bay through a five-mile outfall at 200 feet of depth.

Sludge from primary treatment and about one half of the sludge from secondary treatment (i.e. waste activated sludge) is anaerobically digested. The remainder of the waste activated sludge is given aerobic digestion with a two-day detention time. After screening, digested sludge is combined with some secondary effluent (ratio of 1 gallon of liquid sludge to 3 gallons of effluent) and discharged to the head of a submarine canyon through a seven-mile outfall at 330 feet of depth at the head of a submarine canyon. Gas from anaerobic digestion is used in internal combustion engines to generate electricity and provides power for all plant operations except the effluent pump station. Excess digester gas is sold to the Department of Water and Power for use in the Scattergood Steam Plant located adjacent to Hyperion. During 1978, a daily average of 1,200,000 cubic feet (out of a total production of 4,400,000 cubic feet) was provided to the Scattergood Steam Plant.

Total undigested sludge production at Hyperion in 1978 has been estimated to be about 339 dry tons per day. Digestion destroyed about 175 dry tons per day, and the remaining 164 dry tons were discharged to the Pacific Ocean through the seven-mile outfall.

LOS ANGELES COUNTY SANITATION DISTRICTS (LACSD)

Organized under Chapter 3, Division 5 of the California Health and Safety Code as a special district, the Los Angeles County Sanitation Districts are a federation of 27 individual county sanitation districts serving the 70 cities and unincorporated areas of Los Angeles County. Fifteen of these districts are served by the Joint Outfall System which includes the Joint Water Pollution Control Plant and five water reclamation plants (Whittier Narrows, San Jose Creek, Los Coyotes, Long Beach, and Pomona). Primary and secondary sludges from the water reclamation plants are returned to trunk sewers for treatment at the Joint Water Pollution Control Plant.

Joint Water Pollution Control Plant (JWPCP)

The Joint Water Pollution Control Plant located at the intersection of Figueroa Street and Sepulveda Boulevard in the City of Carson, is the major wastewater treatment complex operated by LACSD and has a rated capacity of 385 MGD for advanced primary treatment. The plant boundaries encompass a total of about 300 acres of which about 200 acres are available for wastewater system uses.

Currently, no secondary treatment is provided, although construction of secondary treatment facilities for 200 MGD of primary effluent is under way and expected to be completed by 1983. Influent flow in 1978 was reported to be about 345 MGD.

Wastewater treatment at JWPCP consists of screening, grit removal, chemical flocculation, primary sedimentation, fine screening, and intermittent chlorination. When construction is completed, secondary treatment will be provided by the activated sludge process. Grit, fine screenings, and digester cleanings are hauled to Palos Verdes Landfill. Treated effluent is discharged to the Pacific Ocean off Palos Verdes Peninsula at depths of 165-200 feet through ocean outfalls which are about 2 miles long.

Primary sludge produced at JWPCP is anaerobically digested and dewatered with centrifuges. Centrate from dewatering is blended with treated effluent, chlorinated on a seasonal basis, and discharged to the ocean through the outfall system. In 1978, about 515 dry tons per day of undigested sludge was produced. After digestion a total of about 330 dry tons per day remained for disposal via reuse, landfilling, and ocean outfall.

A portion of the dewatered sludge (in 1978 about 60 dry tons per day on a 7-day per week basis) was windrow composted. At the treatment plant, composted sludge and dewatered sludge are placed together in trucks and applied to the compost beds in windrows. After application, windrows are mixed and aerated by turning with large diesel powered machines. At the end of the windrow cycle composted sludge containing 60-70 percent solids is removed from the beds and is sold to wholesale and retail markets through a privately owned fertilizer company located at the treatment plant.

Dewatered sludge which is not composted is trucked to Puente Hills and Palos Verdes landfills (the latter on an emergency basis only) for disposal. In 1978, on the average about 80 dry tons per day (7-day per week basis) were trucked to landfills. LACSD reports that 1978 was an unusual operating period because of extremely wet weather during the early part of the year and concern for excessive operating costs. Operations have since been adjusted to increase the amount of dewatered sludge trucked to landfills. During the first six months of 1979, an average of 120-140 dtpd were landfilled. In June 1979 alone, a daily average of 145 dtpd was landfilled.

Storage (three days) for dewatered sludge is provided at the wastewater treatment plant. Gas from anaerobic digestion is used in internal combustion engines to generate electricity and provides power for all plant operations except solids processing facilities, chlorination station, some digesters, and other minor operations. Digester gas is also used in boiler systems to provide steam for digester heating. Excess digester gas is marketed to an adjacent oil refin-

ery or flared when not in demand. In 1978, a total of about 900.9 million cubic feet of digester gas was marketed to Fletcher Oil Refinery while about 1,182 million cubic feet were used within JWPCP.

ORANGE COUNTY SANITATION DISTRICTS (OCSD)

Orange County Sanitation Districts (OCSD) consist of the seven sanitation districts which serve the populous northwestern portion of Orange County. OCSD operates two treatment works -- Reclamation Plant No. 1 located in Fountain Valley (Ellis Avenue near the San Diego Freeway) and Treatment Plant No. 2 located in Huntington Beach (at Brookhurst and the Pacific Coast Highway). Together these facilities are referred to as the "Joint Works".

Joint Works

In 1978, OCSD collected and treated a total wastewater flow of about 191 MGD. All flows receive primary treatment consisting of screening and sedimentation. Approximately 50 MGD of primary treated wastewater receives secondary treatment by means of the activated sludge process. Secondary treatment facilities for an additional 75 MGD of primary effluent are under construction and projected to be in operation in 1981. Treated wastewaters are pumped through a five mile outfall for ocean disposal at a depth of 200 feet.

Sludge is anaerobically digested and dewatered with centrifuges. Centrate from dewatering is blended with treated effluent and discharged to the ocean through the outfall system. Additional dewatering capacity by means of belt presses is being added. Digester gas is used to heat digesters and drive engines. Grit, screenings, and digester cleanings are trucked to Coyote Canyon Landfill.

Until June 1979, dewatered sludge was trucked from the Joint Works for disposal by a fertilizer company under contract to OCSD. Beginning in June 1979, a sludge processing and disposal operation was initiated at Coyote Canyon Landfill in cooperation with the Solid Waste Management Division of the Orange County General Services Agency. This operation would be concurrent with the County's lease for the landfill operation -- currently projected to expire in July 1981 (Ref. 1).

Dewatered sludge is trucked from the Joint Works to the Coyote Canyon Landfill in Orange County. At the landfill, dewatered sludge is spread on base material consisting of dried sludge and allowed to air dry for about 24 hours. At the end of the drying period, sludge and base material are mixed and shaped into windrows. Windrows are mixed and aerated daily until the solids content reaches 35-50 percent (about four days during summertime conditions). At the conclusion of the windrow cycle, dried sludge is stacked into deep piles and held for removal for use as soil supplement, disposal in Coyote Canyon Landfill, or mixing with dewatered sludge.

In 1978 about 150 dry tons per day of undigested primary and about 30 dry tons per day of undigested waste activated sludge were produced. After digestion, a total of about 117 dry tons per day (94 dtpd primary and 23 dtpd waste activated) remained for disposal.

SOUTHERN ORANGE COUNTY SANITATION AGENCIES

In addition to LA/OMA Project, other wastewater and/or water agencies in Orange County, i.e., Aliso Water Management Agency (AWMA), Southeast Regional Reclamation Authority (SERRA), and Irvine Ranch Water District (IRWD), are formulating and proceeding with sludge management plans and programs.

These programs are in the formative stage and may require several years to implement. Recognizing that residual sludges within Orange County will likely require disposal to land for several years, OCSD has proposed to the Southern Orange County Sanitation Agencies that a joint use facility serving all of Orange County be developed. (Ref. 1.)

SLUDGE LOADS AND CHARACTERISTICS

Review of existing practices shows that substantial amounts of digested primary sludge are being managed by the operating agencies. In addition, waste activated sludge is being produced by OCSD and CLA, and beginning in 1981, waste activated sludge will also be produced by LACSD. The waste activated sludge results from improved wastewater treatment and is of concern because of poor mechanical dewatering characteristics.

PROJECTED SLUDGE LOADS

Projected maximum raw sludge loads are given in Table I-1 for each of the operating agencies. Except for Los Angeles County Sanitation Districts, it has been assumed that full secondary treatment of all wastewaters will occur by 1985. LACSD has indicated that planning should assume full secondary treatment by 1990. Examination of Table I-1 shows that the major increase in sludge loads should occur by year 2000. In view of such finding, year 2000 sludge volumes have been selected as the basis for evaluation of alternatives.

Projected sludge loads for the year 2000 are compared with 1978 levels in Table I-2. Under conditions of full secondary treatment of all wastewaters, the total digested sludge load by the year 2000 is projected to be approximately double the total digested sludge load in 1978. Included in the projections are primary and waste activated sludges from treatment of 150 MGD of wastewater at upstream water reclamation facilities which will be processed at the Joint Water Pollution Control Plant (JWPCP). Similarly, projections for the City of Los Angeles include primary and waste activated sludges from treatment of 115 MGD at upstream facilities which will be processed at Hyperion. (Ref. 2,3.)

If a joint use facility serving all of Orange County is realized, the following year 2000 sludge loads from Southern Orange County Sanitation Agencies would be combined with sludges from OCSD for processing and disposal on land. (Ref. 1)

Aliso Water Management Agency	19 dry tons per day
Irvine Ranch Water District	30 dry tons per day
Southeast Regional Reclamation Authority	33 dry tons per day

MARINE SECONDARY

Section 301(h) of the Federal Water Pollution Control Act Amendments of 1977 describes a provision for waiver of requirements for full secondary treatment of wastewater by the EPA Administrator and defines conditions under which the waiver may be granted. Since each of the operating agencies have applied for such waiver, levels of treatment and sludge production shown in Table I-2 under both "Full" and "Marine Secondary" have been assumed for purposes of evaluation of sludge management alternatives. It can be seen that in total, the assumed levels under marine secondary would result in about a 70 percent increase in digested sludge production over 1978 levels and, depending on the agency, range from 72 to 88 percent of the sludge produced under full secondary treatment conditions.

TABLE I-1
PROJECTED MAXIMUM RAW SLUDGE LOADS
LA/OMA OPERATING AGENCIES

CITY OF LOS ANGELES						
YEAR	POPULATION ⁽¹⁾ (MILLIONS)	INFLUENT FLOW ⁽²⁾ (MGD) ⁽³⁾	INFLUENT S.S. (DTPD)	PRIMARY SLUDGE ⁽²⁾ (DTPD) ⁽⁴⁾	WAS ⁽²⁾ (DTPD) ⁽⁵⁾	TOTAL SLUDGE ⁽²⁾ (DTPD) ⁽²⁾
1980	2.94	360	405	275	-	-
1985*	3.03	365	425	290	205	495
1990	3.13	375	445	305	210	515
2000	3.29	400	470	320	220	540
2010	3.29	400	470	320	220	540
2020	3.29	400	470	320	220	540

LOS ANGELES COUNTY SANITATION DISTRICTS						
YEAR	POPULATION ⁽¹⁾ (MILLIONS)	INFLUENT FLOW ⁽²⁾ (MGD) ⁽⁶⁾	INFLUENT S.S. (DTPD)	PRIMARY SLUDGE ⁽²⁾ (DTPD) ⁽⁷⁾	WAS ⁽²⁾ (DTPD) ⁽⁸⁾	TOTAL SLUDGE ⁽²⁾ (DTPD) ⁽²⁾
1980	3.72	365	680	530	-	530
1985	3.77	300	705	550	130	680
1990*	3.84	310	720	560	200	760
2000	3.97	330	755	590	210	800
2010	4.10	355	790	615	230	845
2020	4.23	380	830	645	245	890

ORANGE COUNTY SANITATION DISTRICTS						
YEAR	POPULATION ⁽¹⁾ (MILLIONS)	INFLUENT FLOW ⁽²⁾ (MGD)	INFLUENT S.S. (DTPD)	PRIMARY SLUDGE ⁽²⁾ (DTPD) ⁽⁹⁾	WAS ⁽²⁾ (DTPD) ⁽¹⁰⁾	TOTAL SLUDGE ⁽²⁾ (DTPD) ⁽²⁾
1980	1.60	190	270	175	-	-
1985*	1.76	215	305	200	140	340
1990	1.93	235	340	220	150	370
2000	2.21	280	405	260	180	440
2010	2.46	315	465	300	200	500
2020	2.60	340	500	325	215	540

* Assumed onset of full secondary treatment of all wastewaters.

- (1) LACSD figures based on SCAG-1978 Projections for the Joint Outfall System. Other figures based upon wastewater facilities planning information provided by the respective agencies.
- (2) Values rounded to nearest 5 units. Does not include effects of sidestream recycle.
- (3) Total flows in City of Los Angeles wastewater system which contribute to sludge loading at Hyperion.
- (4) Based upon 68 percent removal of suspended solids in primary sedimentation.
- (5) Based upon a waste activated sludge yield of 0.56 tons per million gallons of influent flow.
- (6) Total flows to Joint Water Pollution Control Plant. 1980 values reflect 75 MGD at upstream facilities. By 1985 upstream treatment will be 150 MGD and remain constant through 2020.
- (7) Based upon 78 percent removal of suspended solids in primary sedimentation.
- (8) Based upon a waste activated sludge yield of 0.64 tons per million gallons of influent flow.
- (9) Based on 65 percent removal of suspended solids in primary sedimentation.
- (10) Based upon a waste activated sludge yield of 0.64 tons per million gallons of influent flow.

TABLE I-2
COMPARISON OF PROJECTED SLUDGE LOADS WITH 1978 LEVELS
LA/OMA OPERATING AGENCIES

TREATMENT PLANT	SECONDARY TREATMENT LEVEL		YEAR 2000 SLUDGE LOADS					1978 TOTAL DIGESTED (DTPD)(b)(h)	DIGESTED SLUDGE INCREASE (k) PERCENT	
	YEAR 2000 (MGD)	1978 (MGD)	PRIMARY (DTPD)(b)(g) (j)	TOTAL-RAW (DTPD)(b)(g) (j)		TOTAL DIGESTED (DTPD)(b)(h)(i)				
				WAS (a) (DTPD)(b)(g) (j)						
<u>FULL</u>										
LACSD (c)	330	0	590	210	800	570	330	73		
OCSD (d)	280	50	260	180	440	320	115	174		
CLA (e)	400	100	320	220	540	390	165	138		
Total	1,010		1,170	610	1,780	1,280	610	109		
<u>MARINE</u>										
LACSD	200		590	130	720	505	330	53		
OCSD	150		260	95	355	250	115	114		
CLA	150		320	85	405	280	165	71		
Total	500		1,170	310	1,480	1,035	610	69		

- (a) Waste activated sludge resulting from secondary treatment.
(b) Dry tons per day.
(c) Joint Water Pollution Control Plant operated by Los Angeles County Sanitation Districts. Year 2000 projections provided by LACSD.
(d) Orange County Sanitation Districts - Joint Works.
(e) Hyperion Treatment Plant operated by the City of Los Angeles.
(f) Term used by LA/OMA Project to describe a level of secondary treatment that may be permitted pursuant to Section 301(h) of the Clean Water Act Amendments of 1977. The values shown have been assumed by LA/OMA Project only for purposes of evaluation of sludge management alternatives and should not be construed as approved pursuant to Section 301(h).
(g) Undigested Sludge.
(h) Total after anaerobic digestion.
(i) Includes sidestream recycle effects.
(j) Does not include sidestream recycle effects.
(k) Percent increase over 1978 levels projected to occur by year 2000.

SLUDGE CHARACTERISTICS

Two broad categories of alternatives for sludge management exist -- resource recovery and disposal. Resource recovery options include energy recovery and production of compost for use as a soil conditioner. Disposal options include landfilling and ocean disposal. Sludge characteristics -- the amounts of organic matter and chemicals in the sludge -- can affect the resource recovery potential because of concern for public health and environmental management. Sludge quality may be independent of the options for resource recovery.

EXISTING CHARACTERISTICS

Sludge characteristics vary among the three operating agencies. This is not surprising, since each of the agencies operate large regional systems with a particular set of industrial contributors. Existing sludge characteristics are presented in Table I-3 for each of the operating agencies. In general, the characteristics shown are based upon data collected in 1978.

In terms of current sludge characteristics, OCSD sludges are notably high in cadmium while LACSD sludges have considerably higher concentrations of lead, chromium, and DDT. Other chemical characteristics are comparable among the three operating agencies. It is also worthwhile to note that measurements indicate that chemical characteristics (in terms of heavy metals and trace organics) of digested primary sludges and undigested waste activated sludges are not markedly different. Sanitary engineering principles indicate that, after digestion, concentrations of these substances in waste activated sludge would be increased and could be elevated above values found in digested primary sludges. However, in terms of emission rates, the two sludges are generally expected to be equivalent.

PROJECTED CHARACTERISTICS

Federal Water Pollution Control Act Amendments of 1977 mandate implementation of industrial source control programs to preclude discharge of substances to the sewerage system which would interfere with sludge reuse or disposal programs. Projections of sludge characteristics have been made assuming that EPA pretreatment requirements for electroplating industries were to be applied to all known industrial discharges to the respective sewerage systems. While it is recognized that non-electroplating industries may or may not ultimately be subject to less stringent pretreatment limits, limits for such industries were not available at the time of the assessment of alternatives. It is known from industrial waste sampling that most of the heavy metals loading is contributed by electroplating industries.

In developing projections of sludge characteristics, mass inputs of certain heavy metals and trace organics to the individual treatment plants are estimated. The amounts of such materials projected to be contained in the sludge and wastewater effluent respectively were then estimated based upon the type of wastewater treatment employed (i.e., primary treatment and activated sludge for secondary treatment). Concentrations were then calculated by division (i.e., mass of toxicant contained in the sludge divided by the total mass of sludge solids). It should be noted that because of destruction of volatile solids, the mass of composted sludge solids is less than that of digested sludge solids.

TABLE I-3
EXISTING SLUDGE CHARACTERISTICS
LA/OMA OPERATING AGENCIES

(Developed from Data Collected in 1978)

CONSTITUENT	DIGESTED PRIMARY SLUDGE				WASTE ACTIVATED SLUDGE		
	CLA (HTP)	LACSD (JWPCP)	OCSD (#1 & #2)		CLA (HTP)	LACSD (JWPCP)	OCSD #1
Total Solids (%WT)	2.3	3.0	2.3	2.3	0.6	0.9	0.5
Total Nitrogen (%TS)	8	5	9	6	8.5	8.5	-(a)
N - Organic	4	3	6	3	8	8	-
N - NH ₃	4	2	3	3	0.5	0.5	-
Total Phosphorus (%TS) as P	2				5	2	-
Total Potassium (%TS) as K	0.5				1	0.7	-
Total Sulfur (%TS) as S		1.3	-	-	-	1.5	-
Trace Metals (mg/kg dry wt)(b)							
Arsenic (As)	25	25			15	10	-
Mercury (Hg)	15	5			5	2	
Silver (Ag)	100	45	60	60	150	15	65
Cadmium (Cd)	135	65	500	170	50	70	150
Nickel (Ni)	600	450	400	300	125	225	340
Lead (Pb)	700	1000	1000	500	30	275	550
Chromium (Cr)	600	2000	900	850	800	850	800
Copper (Cu)	1700	1100	3000	2000	1000	700	2200
Zinc (Zn)	3000	3500	3000	2400	1400	2000	1500
Trace Organics (mg/kg dry wt)(b)							
DDT's	0.4	11	-	0.2	ND(c)	11	0.5
Other Pesticides	0.2	0.3(d)	-	-	-	-	-
PCB's	2.0	3	-	6	ND	3	8
TICH (e)	2.6	14.3	-	6.2	ND	14	8.5

SOURCE: Technical Report #3 "Municipal Sludge Characteristics - City of Los Angeles, LACSD & OCSD" as amended.

(a) Indicates not measured.

(b) Total amount contained in the liquid and solid fractions.

(c) ND = below detection limits.

(d) From 1979 data for BHC, Heptachlor, and Heptachlor Epoxide.

(e) TICH = Total identifiable chlorinated hydrocarbons calculated as the arithmetic sum of the above organics.

In projecting the mass inputs of certain heavy metals and trace organics to the treatment plants, contributions from domestic sources were first estimated. Industrial contributions were then estimated from historical measurements of industrial flows and concentrations. The total of the estimated domestic and industrial contributions were compared with the measured total mass inputs to the treatment plants for purposes of verification. Where significant disparity was noted between estimated and measured values, projected industrial flows and concentrations were in combination varied, based upon knowledge of industrial practices and reliability of data to eliminate such disparity.

Projected mass input of certain heavy metals and trace organics shown in Table I-4 were calculated from application of the pretreatment limits for electroplating industries proposed by EPA in February 1978 (43 FR 6560, February 14, 1978). These limits were promulgated as final regulations in September 1979 (44 FR 2, September 7, 1979). While minor adjustments were made in limits for silver, lead, chromium, copper, and zinc, such adjustments do not significantly alter the projections of mass inputs to the treatment plants from those based upon the February proposal.

Since trace metals and trace organics are in most cases associated with sludge solids as opposed to the effluent, the level of secondary treatment is of importance. Projected sludge characteristics were therefore developed assuming secondary treatment of all wastewaters (full secondary) and secondary treatment of a portion of the wastewater (marine secondary). Certain metals, however, are not substantially affected by the wastewater treatment process, most notably of which is nickel which tends to remain largely in the effluent. Most metals such as cadmium and copper, however, tend to be entrained in the sludge.

Partition efficiencies (between effluent and sludge) for secondary treatment were determined from operation of a pilot scale oxygen activated sludge treatment plant by LACSD at the Joint Water Pollution Control Plant. These partition efficiencies were used in calculation of sludge characteristics for each of the operating agencies.

Projected sludge characteristics (assuming that EPA pretreatment requirements proposed in February 1978 were to be applied to all known industrial discharges to the sewerage system) for year 2000 sludge loads are given in Table I-5. Comparison of these projected characteristics with those that would result under the final pretreatment requirements promulgated by EPA in September 1979 show minor differences in sludge characteristics between the proposed (February 1978) and the final (September 1979) pretreatment requirements. In view of the indicated small difference and since previous work had been completed using the proposed pretreatment requirements, analyses of the proposed program are based upon sludge characteristics shown in Table I-5.

Significant reductions in most heavy metals concentrations in sludges appear achievable through application of pretreatment programs. Known metal plating industrial discharges offer the best prospects for immediate large scale reductions. Some heavy metals (mercury and arsenic) and chlorinated hydrocarbons (DDT and PCB) are not projected to change as a result of industrial pretreatment programs.

TABLE I-4
ESTIMATED TOXICANT INPUTS TO WASTEWATER SYSTEMS
LA/OMA OPERATING AGENCIES

TOXICANT (TOTAL)	INPUTS AS DETERMINED FROM 1977 OPERATING AGENCY MEASUREMENTS			PROJECTED INPUTS FOR YEAR 2000 SLUDGE LOADS UNDER PROPOSED EPA PRETREATMENT REQUIREMENTS (a)				PERCENT REDUCTION
	CLA	(lbs/day)		CLA	(lbs/day)		TOTAL	
		LACSD	OCSD		LACSD	OCSD		
Mercury	9.5	4.1	-	11	4	-	-	0(b)
Arsenic	30	31	-	34	31	-	-	0(b)
Silver	157	50	28	140	50	43	233	0.8
Cadmium	105	84	106	26	20	30	76	74
Nickel	640	744	260	298	92	241	631	62
Lead	175	838	292	174	124	220	518	60
Chromium	810	1,549	430	139	168	170	477	83
Copper	1,160	939	890	702	264	609	1,575	47
Zinc	2,000	3,471	1,300	1,500	999	984	3,483	49
DDT's	1.1	6	0.3	1.1	6	0.3	7.2	0(b)
PCB's	4.5	7	3.2	4.5	7	3.2	14.9	0(b)

SOURCE: LA/OMA Technical Report #18, "Projected Municipal Sludge Characteristics". 1979.

(a) Assuming that proposed EPA pretreatment requirements for electroplating industries are applied to all industrial sources.
(b) No point discharge of these toxicants by industrial sources has been identified by LA/OMA operating agencies. This is, therefore, believed to be unaffected by pretreatment requirements.

TABLE I-5

PROJECTED SLUDGE CHARACTERISTICS FOR LA/OMA OPERATING AGENCIES,
YEAR 2000 PROPOSED EPA PRETREATMENT REGULATION (a)

(mg/dry kg)

TOXICANT	FULL SECONDARY TREATMENT			MARINE SECONDARY TREATMENT ^(b)		
	CLA	LACSD	OCSD	CLA	LACSD	OCSD
<u>Digested Combined Primary and Waste Activated Sludge</u>						
Mercury	13	4	-	12	4	-
Arsenic	34	24	-	34	23	-
Silver	159	44	60	151	42	61
Cadmium	30	18	42	28	17	41
Nickel	182	42	180	164	42	173
Lead	207	115	322	191	115	334
Chromium	168	158	251	152	156	258
Copper	885	260	941	799	252	912
Zinc	1690	877	1360	1590	873	1450
DDT's	1.4	4.9	0.4	1.2	4.7	0.4
PCB's	5.4	5.7	4.8	5.1	5.5	4.9
<u>Composted Combined Primary and Waste Activated Sludge</u>						
Mercury	19	5	-	16	5	-
Arsenic	49	35	-	49	33	-
Silver	230	63	87	217	60	88
Cadmium	43	26	61	40	24	59
Nickel	263	62	260	235	60	250
Lead	300	164	465	274	165	483
Chromium	243	226	364	219	223	373
Copper	1280	370	1360	1147	360	1320
Zinc	2441	1250	1960	2280	1250	2100
DDT's	2.0	7.3	0.6	1.8	6.8	0.6
PCB's	7.8	8.5	7.0	7.3	7.9	7.0

SOURCE: LA/OMA Project, Technical Report #18, Projected Municipal Sludge Characteristics, 1979.

- (a) As proposed in 43 FR 6560, February 14, 1978.
 (b) Level of secondary treatment that would be provided if a waiver of secondary treatment requirements were to be granted.

Industrial pretreatment programs will not totally eliminate heavy metals from sludges. Domestic and uncontrollable sources currently exist and, as industrial contributions decline, will become a greater proportion of the total mass input to the treatment plants.

Under the assumptions of this analysis, there does not appear to be great difference in sludge characteristics between full secondary treatment and marine secondary treatment. The projections reported herein do not assume that credit for removal in the publicly owned treatment works is used to liberalize pretreatment requirements. Prospects for application of such credits are uncertain at this time. It should be noted, however, that reduced pretreatment levels should result in greater accumulations of heavy metals in sludges. In the final analysis, concern for sludge quality may be of more importance than effluent quality in the establishment of industrial pretreatment requirements by local operating agencies.

Projections of sludge characteristics are based upon full compliance with EPA pretreatment requirements. Obviously, less than full compliance will result in sludge characteristics poorer than those shown in the projections. It should be noted that access to the sewerage system is virtually unrestricted. Thus, opportunity exists for unwarranted discharges of substances that would otherwise be precluded from the sewerage system. Availability of economical alternatives (from the perspective of the waste discharger) may reduce this potential.

The sludge characteristics that can be expected to actually be attained lie between those existing now (Table I-3) and those projected above (Table I-5). It should be noted that the analysis indicates that actually realized sludge characteristics should approach the projected values rather than the existing characteristics which are considered to be a reasonable worst case for purposes of analysis.

**DEVELOPMENT OF THE
SLUDGE MANAGEMENT PROGRAM**

DEVELOPMENT OF THE
SLUDGE MANAGEMENT PROGRAM

During preparation of individual wastewater facilities plans by the wastewater agencies, it became apparent that a regional evaluation of sludge management alternatives would be desirable. During 1973, discussions were held concerning alternative proposals for a program which could be accomplished via a facilities planning grant from the Federal/State Clean Water Grant Program.

The Clean Water Grant Program is authorized under the Federal Water Pollution Control Act and Division 7 of the California Water Code. The facility plan is the first step (hence the term "Step I") in a three-step process of assistance for construction of municipal sewage treatment works with federal grants from the Environmental Protection Agency (EPA) supplemented by state grants and local funds. The second step (Step II) is preparation of detailed design plans and specifications. The third and final step (Step III) is construction of the treatment works. Each step must be approved individually by the State, acting through the State Water Resources Control Board (SWRCB) and by the Environmental Protection Agency (EPA). In California, EPA has delegated approvals to the State.

In February 1974, the City of Los Angeles, the Los Angeles County Sanitation Districts and the Orange County Sanitation Districts agreed to enter into a joint powers agreement and submit an application for a Step I planning grant. A management structure was proposed, discussed, and modified in the Spring of 1974. Execution of a joint powers agreement was completed in October 1974. The agreement establishes a high-level Policy Board consisting of representatives of the three operating agencies, the SWRCB, and EPA Region IX, which provides policy direction for the LA/OMA Project. Continuing policy guidance was provided by the "Joint Goal Statement" approved by the Policy Board on June 16, 1975.

The joint powers agreement designates County Sanitation Districts of Los Angeles County as lead agency to obtain and administer the Step I Grant for LA/OMA Project. In June 1975, a grant of \$2.0 million was awarded by SWRCB and EPA. With submittal in August 1976 of a detailed workplan (Ref. 4), the grant was increased to provide a total LA/OMA Project budget of \$3.4 million. With exception of the deep ocean disposal alternative, Clean Water Grant funds were used to provide support for staff studies, hands-on demonstration and field studies, and specialized consultant assistance.

With regard to deep ocean disposal, EPA and SWRCB stated that Clean Water Grant funds could not be used to study alternative means for ocean disposal of sludge since such alternatives are precluded by State and Federal regulations (Ref. 5). Local agencies participating in LA/OMA Project, however, believed that disposal in deeper waters at greater offshore distances would result in disposal well away from zones of high biological productivity with potential for reduced adverse impacts on the marine environment. To assure that all alternatives were investigated and the widest range of choices provided, the local agencies provided separate funding for study of the deep ocean alternative.

A multidisciplinary team of staff and consultants was assembled under the overall direction of a Project Manager. Project staff were organized into engineering, environmental, and public affairs components. Specialized consultant assistance in the area of sanitary engineering, environmental sciences, marine biological resources, and marketing were retained. Demonstration studies were conducted by the local participating agencies, University of California at Riverside, and private sector firms under the direction of Project Staff. Demonstration studies included cultivation of crops on sludge amended soils; pyrolysis of refuse and sewage sludge, thermal pretreatment of sludge; composting, dewatering, dehydration, and combustion of sludge; landfilling of dewatered sludge; and solar evaporation of liquid sludge. A Staff Review Committee consisting of representatives of each of the participating agencies provided technical assistance, advice, and recommendations during development of the sludge management plan.

The facility plan for sludge management prepared by LA/OMA Project will be supplemented by project reports prepared by each of the operating agencies. These project reports will address details of design which are beyond the scope or authority of LA/OMA Project.

JOINT GOAL STATEMENT

One of the earliest activities was the establishment of a statement of planning goals and policy for continuing guidance of LA/OMA Project activities. This effort culminated with adoption of the following Joint Goal Statement by the LA/OMA Project Policy Board on June 16, 1975.

PLANNING PROCESS

The planning approach used was designed to integrate results from three major activities consisting of:

- A series of pilot scale demonstration and field studies of various unit processes and concerns,
- Engineering, environmental, and economic analyses of alternative unit processes configurations, and geographical locations, and
- Public participation in development of alternatives and formulation of the proposed management program.

The results from these activities were combined during the planning process to screen alternatives and determine those options which should be subjected to additional detailed study and further screening. This iterative process was repeated and resulted in identification of alternative sludge management projects.

JOINT GOAL STATEMENT

REGIONAL WASTEWATER SOLIDS MANAGEMENT PROGRAM

LOS ANGELES/ORANGE COUNTY METROPOLITAN AREA

PREMISES

1. Anticipated effects of Federal and State law will be substantially to increase the quantity of residual solids (sludge) produced by wastewater treatment systems.
 - a. Secondary treatment will be provided widely, greatly increasing the amount of sludge produced. Secondary sludges are different from primary sludges in their physical characteristics and may have to be handled differently.
 - b. Full implementation of source control programs will produce substantial quantities of industrial waste solids, some of which are toxic, hazardous and not biodegradable. These should be provided for in any regional solids management system.
2. It is in the public interest to consider wastewater solids as a potentially useful resource and to determine the most satisfactory, cost-effective method of using these solids for the benefit of society.
3. Management of the residual solids produced by a highly industrialized society is complicated by the relatively few options which are environmentally acceptable for their recycle or disposal.
4. A regional solution to solids management in the Los Angeles-Orange County Metropolitan Area may offer advantages not available on a local basis.

GOAL

To develop a long-term plan, including an implementation strategy, to use or dispose of residual solids resulting from industrial and municipal wastewater treatment in the Los Angeles-Orange County Metropolitan Area in an environmentally, economically and socially acceptable manner.

METHOD TO ACHIEVE THE GOAL

1. Organize a team of people involved in wastewater solids management, and include the broadest possible participation by the public as well as political and institutional interests.
2. Conduct an objective study, using this team, which will:
 - a. assess the extent of the problem now and in the foreseeable future;
 - b. identify alternative management systems which appear capable of solving the region's wastewater solids problem, including handling of solids isolated at points of origin as well as those separated from wastewater streams;
 - c. evaluate each alternative to the extent needed to establish its technical feasibility, environmental impacts, cost effectiveness, social implications, political obstacles and legal or institutional changes needed for implementation;
 - d. recommend a preferred long-range solution and a strategy for implementing this solution which is politically realistic.
3. Document the findings and recommendations of the study in a project report and environmental impact statement (combined, if possible), and in public information media, in ways which will encourage prompt implementation of the preferred solution upon completion of the study.

DEMONSTRATION STUDIES

Approximately one-third of the total project budget was allocated to hands-on operation of selected unit processes and field study of key concerns. Results from these studies provided information on process viability, operational characteristics and information for use in environmental analyses. A brief summary of the more significant studies follows:

DECO Pyrolysis Demonstration: Operation of a rated 50 ton per day indirect fired pyrolytic reactor using refuse and sludge refuse mixture.

Vertical Shaft Furnace Tests: Carver-Greenfield dried sludge was gasified in a vertical shaft reactor.

Gasification Tests: Gasification of dried sludge in a 30-inch diameter mono-hearth gasifier to determine performance characteristics.

Thermal Pretreatment Demonstration: Pilot scale evaluation of prospects for increased methane production and enhanced dewaterability from heat treatment of sludges prior to anaerobic digestion.

Carver-Greenfield Demonstration: Field operation of a one effect dehydration process to determine performance characteristics and process viability.

Deep Pile Composting Demonstration: Field study determined feasibility performance characteristics and design criteria of composting of sludge in 10 foot piles and prospects for more intensified use of available lands.

Mechanical Composting Demonstration: Field operation of a mechanical composting system determined performance characteristics, process feasibility and design criteria of within vessel composting systems.

Evaporation Project: Field operation of pilot scale sand drying beds with underdrains determined performance characteristics for solar drying.

Mechanical Dewatering Studies: Pilot scale evaluation of various devices to determine performance characteristics including efficiency of water removal and chemical conditioning requirements.

Agricultural Project: Three year field study of agricultural utilization of liquid and composted sludge to determine soil and crop responses (including field nutrient utilization and uptake of potentially hazardous trace elements) and potential routes for contamination of groundwater and soils. (Note that this work is continuing under the sponsorship of the Kearney Foundation at the University of California at Riverside).

Landfill Demonstration: Field study of moisture relationships, including the ability of solid waste to absorb and hold moisture resulting from mixed disposal of dewatered sludge and solid waste.

Toxicant Removal Studies: Laboratory studies of the feasibility of removal of toxicants from sludge by chemical treatment.

Pathogen Survival Studies: Field and laboratory evaluation of the potential for survival of pathogenic organisms after various unit processes and land application.

TECHNICAL ANALYSES

Various studies have been conducted by Project staff and consultants. These studies include examination of particular aspects as well as the overall evaluation of alternatives. A brief summary of the major studies follows:

State-of-the-Art Survey: The state-of-the-art review was one of the first tasks undertaken by the LA/OMA Project. The purpose of such review was to bring together available information on existing and potential sludge treatment processes as well as methods of ultimate disposal.

Quantitative Analysis: Development and evaluation of costs, energy, and air emissions associated with candidate systems, process options, and alternative projects and comparison of alternative projects.

Engineering Practicability: Evaluation of the qualitative aspects of various candidate systems, process options, and alternative projects and comparison of alternative projects.

Regulatory Compatibility: Assessment of the compatibility of alternative projects with applicable regulatory requirements and comparison of alternative projects.

Regional Environmental Evaluation: A systematic site identification study based upon broad scale environmental and social considerations, such as rare and/or endangered species and adjacent land use.

Environmental Evaluations: Assessment of the potential consequences associated with alternative projects and comparison of projects.

EIS/EIR: Preparation of the environmental impact statement/report describing the environmental consequences of alternatives and impacts associated with the proposed sludge management program.

Carver-Greenfield Process Evaluation (Ref. 16): During development of the state-of-the-art survey, the Carver-Greenfield (CG) process was identified as offering considerable potential for efficient drying of sludge solids. Further evaluation of the process was conducted which drew upon information developed from pilot scale testing, field trips to existing and former installations, combustion tests on the dried product and engineering analysis of the process.

Marketing Studies: Identification of most promising products, the markets for such products, and marketing strategy (including market characteristics and product factors) for distribution of composted sludge.

Exportation Study: Assessment of the feasibility for exportation of liquid digested sludge to overseas markets.

Baseline Ocean Studies: Assessment of effects upon marine environment from past practices and determination of effects under the Baseline Alternative.

Deep Ocean Disposal Study: Assessment of the prospects (using mathematical models) for disposal of sludge in deep ocean basins. (Note that this study was funded solely by the operating agencies).

Nonsewerable Waste Studies: Characterization of the potential for problems associated with current management practices for liquid or semi-solid wastes which may not be placed in the sewerage system.

In addition to the foregoing studies, Project Staff visited sludge management facilities operated by agencies in other parts of the country. These visits yielded important first-hand information regarding experience and actual operating history.

PUBLIC PARTICIPATION

Public participation was sought at the outset of the planning process and was sustained for the duration of the Project. The goals of the public participation program were to:

- Nurture an understanding of the "problems" of sludge management, so the public can understand the "solutions",
- Identify and consider the concerns of the various publics,
- Have the public participate in the identification of, and development of solutions.

In the early phase of the planning program, a significant effort was undertaken to gain public review and comment on the scope and magnitude of the proposed work program, the alternatives to be investigated, and issues associated with the alternatives. As work progressed, emphasis was shifted to general dissemination of information, general participation programs (e.g., Citizens Forums, Interagency Coordination), and efforts related to specific areas and sites under consideration.

Community and neighborhood meetings have been held in affected areas and the results provided for use in the planning process. A public participation program, specific to the evaluation of alternatives, was designed with the following additional goals:

- Identification of the different levels of support or opposition to each project, and
- Identification of concerns with each management project that could possibly be resolved through mitigation.

In this specific program, the publics played an additional role of being a resource base with an intimate knowledge of their own communities.

In the waning months of the Project, public participation program activities focused upon dissemination of information on the proposed management program and the formal public review and hearing associated with the draft environmental impact statement/report.

Several governmental agencies were involved with the Project by correspondence and "interagency coordination" meetings. Representatives of some agencies regularly attended LA/OMA Policy Board meetings.

Those agencies most active with LA/OMA Project were:

- Regional Water Quality Control Boards -- Los Angeles, Lahontan, Santa Ana, and the San Diego Regions
- State Solid Waste Management Board
- South Coast Air Quality Management District
- State Air Resources Board
- State Department of Health Services
- San Bernardino County Department of Environmental Health
- Santa Ana Watershed Planning Agency
- State Department of Fish and Game
- State Energy Resources Conservation and Development Commission

The Southern California Association of Governments (SCAG) is a comprehensive planning agency authorized under Section 208 of the Federal Water Pollution Control Act of 1972. LA/OMA Project will produce the sludge management plan that will be incorporated into the South Coast Areawide Waste Treatment Management Plan. A Memorandum of Understanding was executed between SCAG and LA/OMA Project to coordinate the respective planning programs.

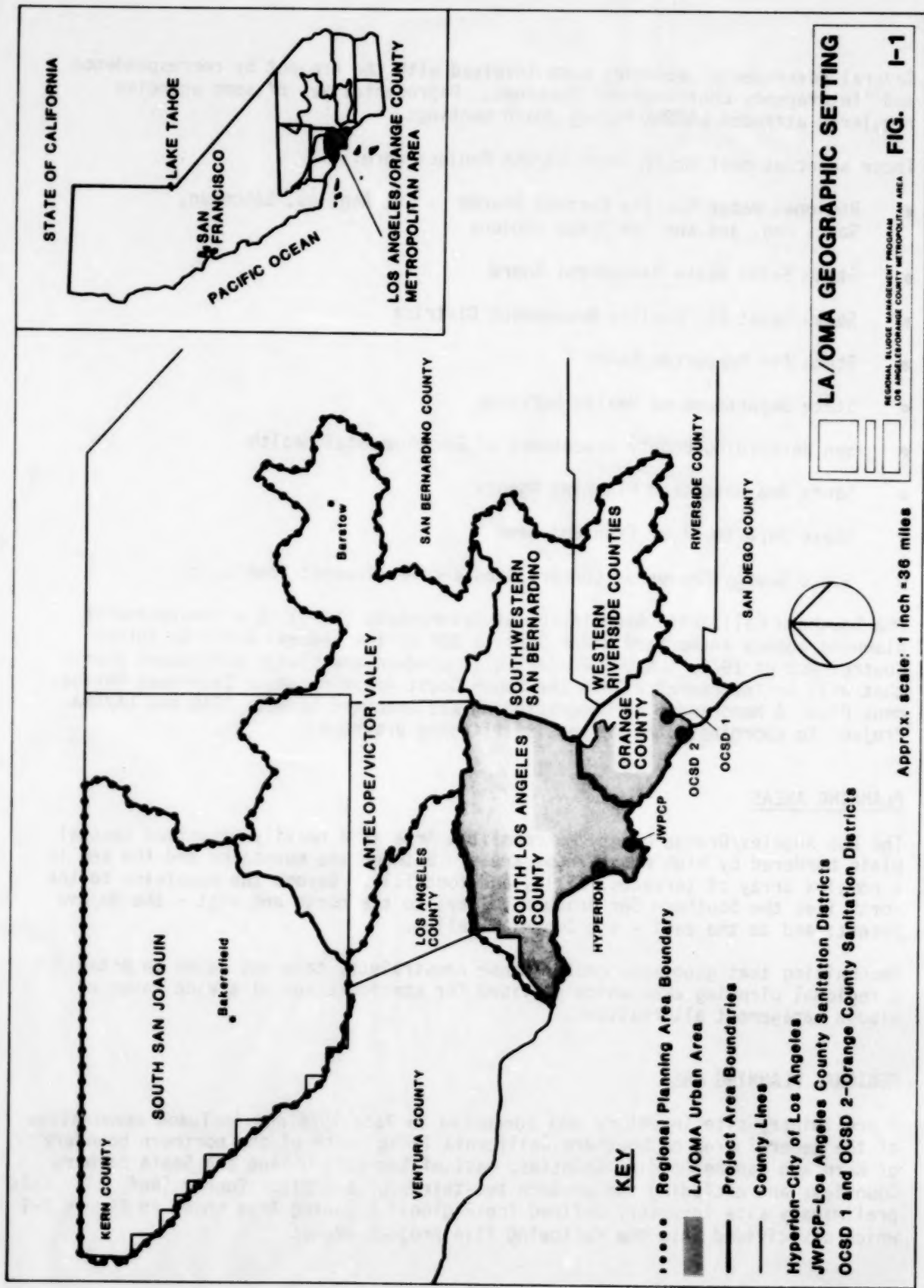
PLANNING AREAS

The Los Angeles/Orange County Metropolitan Area is a heavily urbanized coastal plain bordered by high mountainous areas. Between the mountains and the sea is a complex array of terraces, hills, and foothills. Beyond the mountains to the north lies the Southern San Joaquin Valley; to the north and east - the Mojave Desert; and to the east - the Imperial Valley.

Recognizing that geography could impose constraints, care was taken to establish a regional planning area which provided for consideration of a wide range of sludge management alternatives.

REGIONAL PLANNING AREA

A preliminary site inventory was conducted in late 1976 and included examination of the general area of Southern California lying south of the northern boundary of Kern and San Bernardino Counties, east of San Luis Obispo and Santa Barbara Counties, and excluding the western two-thirds of San Diego County (Ref. 6). This preliminary site inventory defined the Regional Planning Area shown in Figure I-1 which was divided into the following five project areas:



- South Los Angeles County
- Orange County
- Southwestern San Bernardino/Western Riverside Counties
- Antelope/Victor Valley
- South San Joaquin Valley

The Antelope/Victor Valley area is the least developed of the project areas and is largely desert and sparsely populated. Lands within the South San Joaquin Valley are farmed extensively. South Los Angeles County, Orange County, and Southwestern San Bernardino/Western Riverside Counties lie on the coastal side of the mountains and are for the most part urbanized, although some portions of Western Riverside County are rural in nature.

LA/OMA URBAN AREA

The LA/OMA Urban Area is located within the South Los Angeles County and Orange County Project Areas and consists of the service areas of the County Sanitation Districts of Orange County, City of Los Angeles, the Joint Outfall System of the County Sanitation Districts of Los Angeles County, and the area within the cities of Burbank, Glendale, and Hollywood which are served by contract with the City of Los Angeles. This area extends from the San Fernando Valley on the north to the San Gabriel Valley in the east and includes the northern portion of Orange County. Facilities plans prepared by the three wastewater agencies indicate a population of about 8,000,000 persons in 1975, increasing to about 9,500,000 by the year 2000. Existing sludge management facilities are located in this area.

SLUDGE MANAGEMENT PROGRAM DEVELOPMENT

Data on information from the three major activities were brought together for review and assessment at key points in the process and decisions made regarding deletion of unit processes or alternatives and continued study needs. These decision points utilized sources external to the Project Staff inasmuch as the public and interested agencies were invited to participate in the shaping of alternatives. Decisions to delete or otherwise foreclose alternatives were made by the LA/OMA Project Policy Board after due consideration of the information presented.

Key points in formulation of the sludge management program, shown in Figure I-2, were:

- Development and analysis of candidate systems for sludge management that provided information to define fundamental sludge management alternatives.
- Analysis of Sludge Management Alternatives that provided the basis for development of alternative management projects.

- Analysis and comparison of alternative management projects that provided the basis for selection of the proposed management program, and
- Detailed analysis of the proposed management program to prepare the facilities plan and environmental impact statement/report.

Figure I-2 is a schematic diagram of the process that lead to development of the proposed sludge management program. Following is a summary of the detailed discussion contained in Chapter II.

CANDIDATE SYSTEMS

In developing the candidate systems listed in Figure I-2, a step-by-step screening procedure was used. First, processes and ultimate disposal alternatives which have been suggested for the Southern California area were assembled. Each option was then classified as to whether it related to processing of sludge or to its ultimate disposal and/or reuse. Finally, each ultimate disposal alternative and unit process were screened using the results of a state of the art survey of sludge processing and disposal alternatives.

Eighteen sludge processing and disposal trains (candidate systems) resulted from the screening process. Each system was designed to recover at least one of the potential resources contained in sludge, whether it be energy, nutrients, or humus. In addition, each system was considered to be technically feasible, compatible with existing treatment facilities, reasonably cost effective, and devoid of excessive adverse environmental effects.

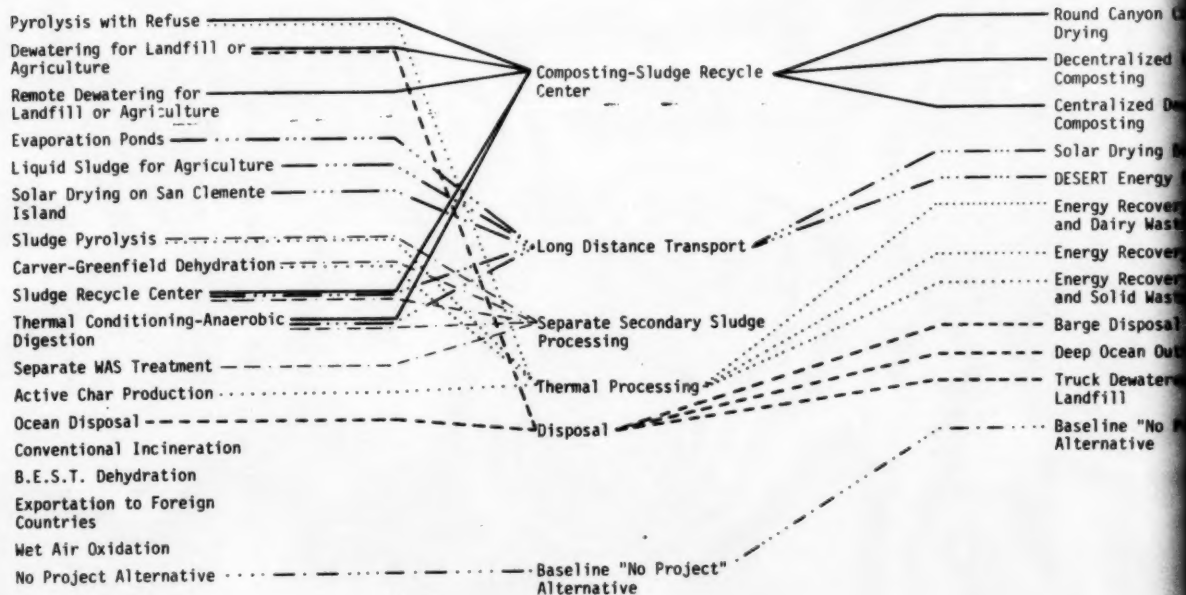
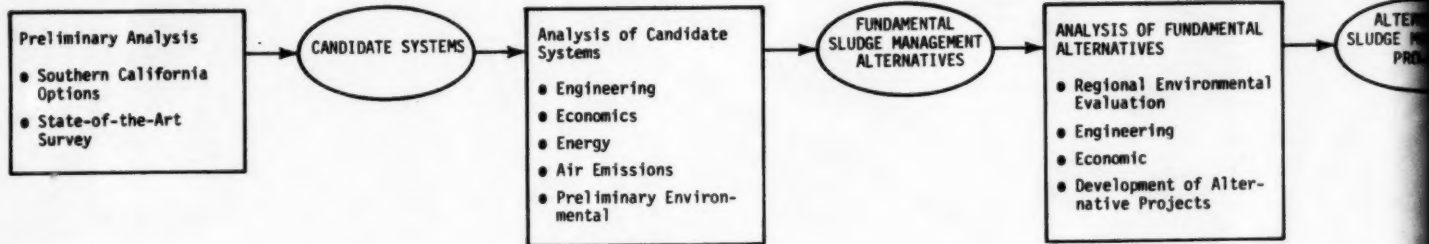
Candidate systems were analyzed in terms of quantitative factors such as costs, energy use, land requirements, and air emissions. A preliminary evaluation of qualitative factors was also conducted which included environmental concerns, implementability, public health concerns, reliability, flexibility, land availability, land use effects, social concerns, and political constraints. Numerous conclusions and recommendations resulted from the analysis and a number of processing and disposal/reuse options were deferred from further consideration. The fundamental sludge management alternatives were formulated from the analysis and encompassed the remaining candidate systems.

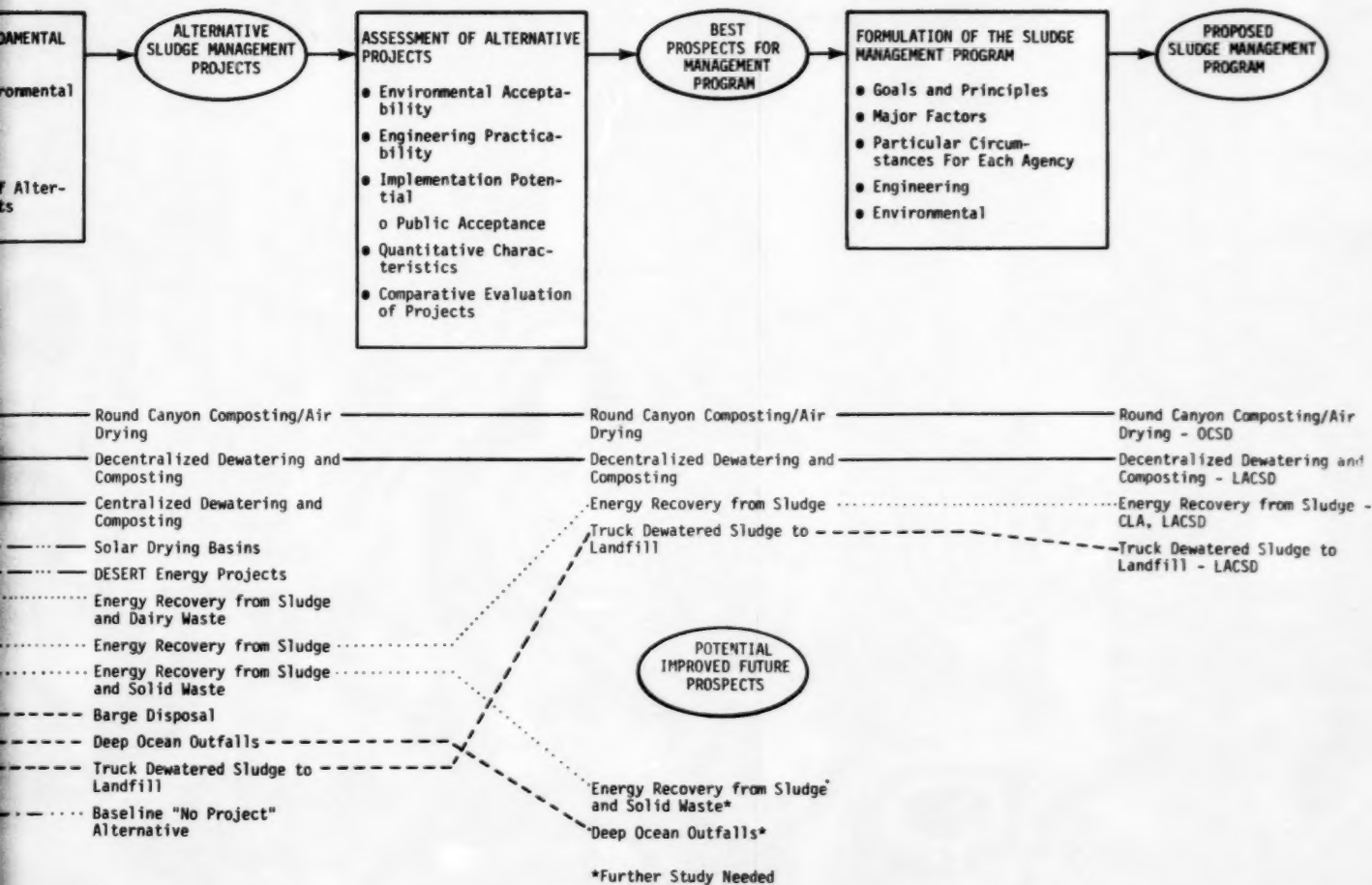
FUNDAMENTAL SLUDGE MANAGEMENT ALTERNATIVES

Concepts embodied in the remaining candidate systems were consolidated into the six fundamental sludge management alternatives shown in Figure I-2. Candidate systems included within each fundamental alternative are also shown in Figure I-2. Where no relationship between candidate systems and fundamental management alternatives is shown, the candidate system was deferred from further consideration. The six fundamental management alternatives are:

Long Distance Transport: Transportation of liquid digested sludge to a location outside the urban area for subsequent processing and disposal/reuse.

Composting - Sludge Recycle Center: Compost and recycle digested dewatered sludge for use as a soil amendment.





DEVELOPMENT OF THE PROPOSED SLUDGE MANAGEMENT PROGRAM

REGIONAL SLUDGE MANAGEMENT PROGRAM
LOS ANGELES/ORANGE COUNTY METROPOLITAN AREA

FIG. 1-2

Thermal Processing: Recovery of energy from digested dewatered sludge by means of combustion or pyrolysis.

Disposal: Initially defined only as ocean disposal of screened, digested sludge, this alternative was expanded to include landfill disposal of digested dewatered sludge during the analysis of the fundamental management alternatives.

Separate Secondary Sludge Processing: Processing of waste activated sludge in facilities separate from primary sludge. During analysis of the fundamental management alternatives, this concept was consolidated with other fundamental alternatives.

Baseline "No Project" Alternative: The "no action" alternative, a baseline against which alternatives may be measured.

A total of 45 different combinations of unit process and ultimate disposal/reuse options were examined in three steps. At the conclusion of each step one or more options were deferred from further consideration until a single process train tied to specific sites and transportation routes was identified for each fundamental management alternative.

REGIONAL ENVIRONMENTAL EVALUATION

This evaluation identified for more detailed investigation parcels of land within each of the five Project areas described earlier which were found to be potentially suitable for location of sludge processing, reuse, or disposal options encompassed by the fundamental management alternatives (Ref. 7). The evaluation process consisted of the following tasks:

- Parcels of land that could potentially be used were identified throughout the 12,000 square miles encompassed by the five Project Areas. Such lands were contained within land use categories designated as agriculture, military land, oil fields, quarries, and vacant lands on existing land use maps. Additionally, lands with slope greater than 15 percent were excluded.
- Environmental factors protected by Federal and State legislation and/or regulations were identified as potential constraints on use of the identified parcels of potentially suitable land. Factors examined were (1) geohydrological constraints consisting of continuity with usable groundwater, flood plain locations, and fault hazard zones; (2) ecological constraints consisting of distribution and occurrence of rare and endangered animals, legally protected rare and endangered plants, legally established sanctuaries and preserves, rare native plants, and unique ecological communities; and (3) prime and potentially prime agricultural lands.
- Potentially suitable parcels of land which survived the environmental constraint screening were evaluated in terms of potential conflicts with adjacent existing land uses.

Parcels surviving this last evaluation were subjected to engineering and environmental evaluations until one or more suitable sites were identified for each of the alternative sludge management projects.

ALTERNATIVE SLUDGE MANAGEMENT PROJECTS

The combination of a unit process train, specific site location(s) and transportation route(s) constitutes an alternative sludge management project. One or more projects were defined for each of the fundamental management alternatives described earlier. Figure I-2 shows the relationship between the projects and the fundamental management alternatives. Detailed analysis and comparison of the alternative sludge management projects provided the basis for selection of the sludge management program for the Los Angeles/Orange County Metropolitan Area.

Each of the alternative projects were analyzed by a team consisting of LA/OMA Project Staff and consultants. These technical evaluations addressed the considerations of engineering practicability, environmental acceptability, implementation potential and quantitative characteristics of each of the alternative sludge management projects. Input from the public participation program was included in the evaluation of implementation potential. Project evaluations focused principally on aspects of the alternative projects which would enable distinctions to be drawn between the alternatives.

Using the results of the evaluations of the alternative projects, advantages/disadvantages were identified for each of the aforementioned considerations and for each alternative project. A broadly defined ranking of the projects within each consideration was established. These rankings were used to compare alternative projects and identify tradeoffs associated with each of the alternatives. From this comparison certain alternative sludge management projects were deleted from further consideration and those alternative management projects with best prospects for inclusion in the sludge management program were identified.

SLUDGE MANAGEMENT PROGRAM SELECTION

The proposed management program was selected from the alternative sludge management projects which survived the comparative evaluation of alternatives. Program selection was guided by goals and principles established as policy direction for preparation of the sludge management program and facilities plan. Consideration was given to the major factors associated with program selection and the particular combinations of circumstances affecting each of the operating agencies. Additional engineering and environmental analyses were conducted as necessary to prepare a facilities plan to serve as the basis for construction grant assistance and a Draft Environmental Impact Statement/Report as required by federal and state environmental legislation.

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1-32(a)

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CHAPTER

II

CHAPTER I

**BACKGROUND AND
PROBLEM DESCRIPTION**

CHAPTER II

**DEVELOPMENT OF THE
ALTERNATIVE SLUDGE
MANAGEMENT PROJECTS**

CHAPTER III

**DESCRIPTION OF THE
ALTERNATIVE SLUDGE
MANAGEMENT PROJECTS**

CHAPTER IV

**COMPARATIVE EVALUATION
OF THE SLUDGE
MANAGEMENT PROJECTS**

CHAPTER V

**DESCRIPTION OF THE
PROPOSED SLUDGE
MANAGEMENT PROGRAM**

CHAPTER VI

**DETAILED PHASE II
FACILITY DESCRIPTIONS**

CHAPTER VII

ANALYSIS OF KEY TOPICS

APPENDICES**CHAPTER II****DEVELOPMENT OF THE
ALTERNATIVE SLUDGE
MANAGEMENT PROJECTS**

- THE CANDIDATE SYSTEMS
- FUNDAMENTAL SLUDGE
MANAGEMENT ALTERNATIVES
- DEVELOPMENT OF THE
ALTERNATIVE SLUDGE
MANAGEMENT PROJECTS
- SITE IDENTIFICATION STUDIES
- ADDITIONAL INFORMATION

DEVELOPMENT OF THE ALTERNATIVE SLUDGE MANAGEMENT PROJECTS

Purpose of this chapter is to present the methodology used in the facilities planning effort undertaken by the LA/OMA Project. Due to the large number of sludge processing and ultimate disposal options, it was essential that the number of alternatives be reduced to a manageable number. As analysis continued, an increasing number of options were deferred from further consideration. Those remaining at the end of the analysis were used to formulate the proposed sludge management program. Figure I-2 is a schematic diagram of the process leading to development of the proposed management program.

Due to the broad scope and duration of the LA/OMA Project, the alternatives under investigation were periodically reorganized to facilitate the analysis. The first group of alternatives were termed Candidate Systems (CS). Following a preliminary engineering analysis and initial site investigation (Ref. 1), a number of options were deferred from further consideration. Those remaining were restructured into six fundamental management concepts, termed Sludge Management Alternatives (SMA). Each concept incorporated a number of permutations so that the total number of systems being considered was still quite large (Ref. 2). To facilitate the analysis, design criteria were developed for each unit process included in the SMA's (Ref. 3). A computer program was written to assist in the analysis (Ref. 4). These tools allowed the engineering studies to be conducted in much greater depth, and were used in all subsequent analysis.

As part of the analysis of the SMA's, efforts were made to locate potentially suitable sites in the metropolitan area and in surrounding desert and agricultural areas. Combining site information with results of the engineering analysis, a number of systems were again deferred from further consideration. Those remaining were again restructured, this time into twelve alternative Sludge Management Projects (SMP). A number of options were still incorporated into each SMP, but these were shortly reduced to a single option for each Project. Also, each Project was tied to specified sites for both processing and ultimate disposal. From the nearly infinite number of possible systems, the analysis had resulted in twelve detailed treatment trains, transportation routes, corresponding sites for processing, and reuse or disposal.

The reduced number of management projects and the detail of their specification allowed serious consideration of all considerations necessary to the decision making process. These considerations were broken into four categories of quantitative engineering analysis, engineering practicality, environmental acceptability, and implementation potential. Public input was incorporated into the study in order to help direct the program and determine impacts of the proposed Projects. Results of the analysis of these considerations is presented in Chapter IV.

Purpose of this chapter is to transition from the original Candidate Systems, through the Fundamental Sludge Management Alternatives, to the Alternative Sludge Management Projects. Attention will be focused on the methodology used and the rationale for deferrment of various systems. Due to the rather enormous output of information generated during the analysis, only brief summaries of results can be presented here. For more information the reader is referred to the cited references.

THE CANDIDATE SYSTEMS

A screening procedure was developed to eliminate from further consideration those processes or ultimate disposal alternatives which did not have a reasonable chance of implementation. The screening exercise followed a definite step-by-step procedure. First, all process and ultimate disposal alternatives which have been suggested for the Southern California regional area were assembled. While an exhaustive effort was made to include all alternatives, it cannot be guaranteed that some rarely used or newly developed processes were not overlooked. Also, it was recognized that new processes may have been proposed and/or developed during the course of the project. Therefore, the screening procedure was developed as an "on-going" exercise that was used whenever new alternatives were presented or discovered.

Second, following assemblage, each option was classified as to whether it related to the processing of sludge or to its ultimate disposal and/or reuse. Information was gathered on all solids processing and disposal alternatives relating to the treatment, final disposition and reuse of sewage solids and a state of the art survey produced (Ref. 5). Finally, each ultimate disposal alternative and sludge process was screened through the set of criteria shown in Table II-1 using the results of the state of the art survey. Those processes and ultimate disposal alternatives which passed the screening procedure were viable options while the rest were eliminated from further consideration. All alternatives were evaluated by these criteria. Failure to pass any of the factors shown in Table II-1 was sufficient to rule out an alternative. All factors were considered equally important in the screening exercise and the listing shown in Table II-1 is not meant to imply any ranking by importance.

TABLE II-1
SCREENING CRITERIA USED IN DEVELOPMENT OF CANDIDATE SYSTEMS

-
- Danger to Public Health
 - Excessive Adverse Environmental Impact
 - Excessive Technical Difficulties
 - Excessive Consumption of Energy or Other Natural Resources
 - Exorbitant Cost
 - Insurmountable Adverse Public Reaction
 - Process Considered Unnecessary at This Time
-

This step-by-step procedure was designed as a logical and necessary vehicle by which to scrutinize sludge disposal alternatives. The magnitude of the screening problem cannot be overemphasized. The number of proposed or contemplated treatment trains and disposal options bordered on infinity. The problem then was to convert a bewildering array of alternatives to a manageable list of potential options for the regional area and, in so doing, give fair and impartial consideration to each individual alternative.

Several relative terms such as "exorbitant" and "excessive" were used in the screening criteria shown in Table II-1. In using the criteria the term "excessive" was applied to any disposal option which produced impacts far greater than other alternatives which might be similar on the basis of other factors. Similarly, the "exorbitant cost" factor was applied to an alternative for which costs greatly exceeded other processes which were as environmentally acceptable. Therefore, the criteria did not represent a fixed scale but rather a relative scale by which one alternative was compared to another.

Processes and ultimate disposal options deferred during formulation of the candidate systems are shown below.

PROCESSES AND ULTIMATE DISPOSAL OPTIONS
DEFERRED DURING FORMULATION OF CANDIDATE SYSTEMS

ALTERNATIVE	BASIS FOR DEFERRAL
Long Distance transport outside California	Lack of demonstrated need.
Lagooning in urban or suburban area	Excessive adverse environmental impact.
Hydrofracturing	Excessive technical difficulties.
"Exotic" disposal systems	Excessive technical difficulties.
Use of raw sludge in any land disposal alternatives	Danger to public health, excessive adverse environmental impact.
Raw sludge disposal to ocean	Danger to public health, excessive adverse environmental impact.
Barge disposal outside continental shelf	High cost, lack of demonstrated need.
Aerobic digestion	Excessive energy consumption compared to anaerobic digestion.
Lime treatment	Considered unnecessary at the time.
Chlorine oxidation	Excessive chemical and energy consumption, considered unnecessary at the time.
Solidification Processes	Considered unnecessary at the time.
Elutriation conditioning	Considered unnecessary at the time.
Freeze conditioning	Lack of demonstrated technology. Considered unnecessary at the time.
Electrical and Ultrasonic Conditioning	Excessive technical difficulties. Considered unnecessary at the time.
Capillary, rotating gravity, and moving screen dewatering devices.	Processes considered unnecessary at the time.
Chemical disinfection	Process considered unnecessary at the time.
Gamma Ray and Electron Beam Irridation for pasteurization	Processes actively investigated but not included as part of candidate systems.

DESCRIPTION OF CANDIDATE SYSTEMS

From those which passed the screening test, 18 sludge processing and disposal trains were assembled. Each system was designed to recover, reclaim or recycle at least one of the potential resources contained in sewage sludge, whether it be energy, nutrients, humus, or others. In addition, each system was considered to be technically feasible, compatible with existing treatment facilities, reasonably cost competitive and devoid of excessive adverse environmental effects.

It should be mentioned that in the original concept only 5 or 6 candidate systems were to be described and studied in detail in keeping with traditional facilities planning practice. However, it became obvious that the extent of potential resource recovery and ultimate disposal alternatives were too great to limit the study to a small number of candidate systems. Rather than limit the management options which would be studied, it was decided to expand the number of candidate systems so that all reasonable approaches could be investigated.

Candidate System 1 - Conventional Incineration

This system would combine primary and thickened secondary sludge, alternatively digest (or not) the combined sludge, condition the sludge either with chemicals or by heat treatment, dewater conditioned sludge, and incinerate the sludge along with some municipal refuse if required to make sludge processing energy self-sufficient. Resultant ash would be trucked to landfill disposal. Four permutations were investigated which covered the range of options for digestion, conditioning, dewatering, and refuse addition.

Candidate System 2 - Sludge Pyrolysis

This system would combine primary and thickened secondary sludge, alternatively digest (or not) the combined sludge, condition the sludge either with chemicals or by heat treatment, dewater conditioned sludge, and pyrolyze the sludge along with some municipal refuse if required to make sludge processing energy self-sufficient. Resultant ash would be trucked to landfill disposal. Four permutations were investigated which covered the range of options for digestion, conditioning, dewatering, refuse addition, and heat recovery.

Candidate System 3 - Separate WAS Treatment

This system would process primary and secondary sludges in separate process trains. Primary sludge would be chemically conditioned, dewatered, and incinerated with resultant ash being trucked to landfill for disposal. Secondary sludge would be thickened, alternatively digested (or not), conditioned either with chemicals or by heat treatment, dewatered, and alternatively heat dried or compost dried. Dried sludge would alternatively be truck transported either to landfill disposal or to agricultural reuse, or rail transported to agricultural reuse. Forty permutations were investigated which covered the wide range of processing variables described above.

Candidate System 4 - Pyrolysis With Refuse

This system would process sludge for delivery to one or more large municipal refuse pyrolysis systems, probably located remote from wastewater treatment plants. Primary and secondary sludge would be combined, anaerobically digested, chemically conditioned, and dewatered. After dewatering, sludge would alternatively be composted (or not) and delivered by truck transportation to the refuse pyrolysis centers. Two permutations were investigated.

Candidate System 5 - Active Char Production

This system would utilize pyrolytic char produced during the pyrolysis of sludge by mixing the char with raw incoming sewage, thus absorbing much of the incoming sewage BOD, and potentially producing a more easily dewaterable primary sludge. Secondary sludge would be minimized because less soluble BOD would remain subsequent to absorption on char. Three permutations were investigated which covered a range of drying options prior to pyrolysis.

Candidate System 6 - B.E.S.T. Dehydration

This system would combine primary and thickened secondary sludge, alternatively digest (or not) the combined sludge, condition the sludge with either chemicals or by heat treatment, dewater conditioned sludge, and dehydrate the dewatered sludge using the B.E.S.T. system. The dehydrated sludge would be alternatively incinerated with the ash being disposed of in landfills, or transported by either truck or rail transport to agricultural reuse, or by truck transport to landfill disposal. Twenty-two permutations were investigated which covered the range of processing, transportation and ultimate reuse/disposal options described.

Candidate System 7 - Carver-Greenfield Dehydration

This system would combine primary and thickened secondary sludge, alternatively digest (or not) the combined sludge, alternatively condition the sludge, and dewater it (or not), and dehydrate the sludge using the Carver-Greenfield multiple-effect evaporation system. The dried sludge would alternatively be incinerated with the resulting ash being truck transported to landfill disposal, or transported to either landfill disposal or agricultural reuse. Alternatively either truck or rail transportation could be used to move the dried sludge to agricultural reuse areas, or truck transportation could be used in connection with landfill disposal. Eighteen permutations were investigated which covered the range of processing, transportation and ultimate reuse/disposal options described.

Candidate System 8 - Dewatering for Landfill or Agriculture

This system would combine primary and thickened secondary sludge, digestion of the combined sludge, and alternatively condition the sludge with either chemicals or by heat treatment. The conditioned sludge would be dewatered, and alternatively compost dried (or not). The dewatered or dried sludge would alternatively be truck or rail transported to agricultural reuse, or truck transported to landfill. Twenty-one permutations were investigated.

Candidate System 9 - Sludge Recycle Center

This system would combine primary and thickened secondary sludge, anaerobically digest the combined sludge, condition the digested sludge either with chemicals or by heat treatment, dewater conditioned sludge, and alternatively either compost dry or heat dry the dewatered sludge. The dried sludge would be stock-piled at recycle centers adjacent to existing treatment works, where it would alternatively be marketed or exported out of the Los Angeles-Orange County metropolitan area. Any excess of dried sludge which could not be marketed or exported would be transported via trucks to landfill disposal. Four permutations were investigated which covered the range of options described above.

Candidate System 10 - Evaporation Ponds

This system would combine primary and thickened secondary sludge, anaerobically digest the thickened sludge, and transport the digested sludge through a pipeline to evaporation ponds where the sludge would be solar dried. The dried sludge would be removed from the ponds and alternatively landfilled or distributed for agricultural reuse purposes. Three permutations were examined covering landfilling and high or low rate agricultural reuse.

Candidate System 11 - Remote Dewatering for Landfill or Agriculture

This system would combine primary and thickened secondary sludge, anaerobically digest the thickened sludge, and provide pipeline transportation of the digested liquid sludge to a remote area for further processing. Further processing would alternatively consist of either chemical or thermal conditioning, dewatering of the conditioned sludge, and alternative compost drying (or not). The dewatered or dried sludge would be truck transported alternatively to landfill disposal or to agricultural reuse. Twelve permutations were investigated which covered the range of options described above.

Candidate System 12 - Liquid Sludge for Agriculture

This system would combine primary and thickened secondary sludge, anaerobically digest the combined sludge, and provide pipeline transportation to storage lagoons. From the storage lagoons, sludge would be transported as a liquid for use in high-rate agricultural reuse.

Candidate System 13 - Solar Drying on San Clemente Island

This system would combine primary and thickened secondary sludge, provide anaerobic digestion of the combined sludge, chemically condition and thicken the digested sludge to 10 percent solids. The thickened sludge would be pipeline transported to coastal barge docks located in the vicinity of each of the existing treatment plants, where it would be loaded onto barges for transportation to San Clemente Island. The sludge would be off-loaded at San Clemente Island and pumped to evaporation ponds for solar dewatering. The dewatered sludge would be composted on San Clemente Island and transhipped back to the mainland via barges for marketing as compost. Any excess composted material which could not be marketed would be truck transported to landfill disposal.

Candidate System 14 - Thermal Conditioning-Anaerobic Digestion

This system would provide thermal conditioning for thickened secondary sludge, and alternatively (or not) for primary sludge. The thermally conditioned sludge would then be anaerobically digested. Digested sludge would alternatively be chemically conditioned (or not) and dewatered, and would alternatively be compost dried (or not). Dewatered or dried sludge would be truck transported either to landfill for disposal or to an agricultural reuse area. Twenty-four permutations were investigated covering the range of processing and ultimate reuse/disposal options described.

Candidate System 15 - Ocean Disposal

This system would involve ocean disposal of liquid digested sludge through either deep ocean outfalls or by barge transport and dispersal. Five permutations were investigated (Ref. 6) which covered a range of outfall and barging configurations. Further discussion of funding restrictions for analysis of ocean disposal is presented later in this chapter.

Candidate System 16 - Exportation To Foreign Countries

This system would combine primary and thickened secondary sludge, anaerobically digest the thickened sludge, and provide pipeline transportation from the existing treatment plants to coastal facilities which would be used to load oil tankers. The sludge would serve the purpose of ballasting such tankers for their return trip back to oil exporting areas, and the sludge would be used for agricultural purposes in the oil exporting countries.

Candidate System 17 - Wet-Air Oxidation

This system would combine primary and thickened secondary sludge, alternatively digest (or not) the combined sludge, and combust the sludge using the wet air oxidation process. The liquid slurry resulting from the wet air oxidation would be gravity thickened and dewatered. If found to be feasible, valuable by-products from the combusted sludge (principally heavy metals) might be recovered. Dewatered ash resulting from the wet air oxidation of the sludge would be truck transported to landfill disposal. Two permutations were investigated.

Candidate System 18 - NEPA-CEQA No Project Alternative

A "no project" alternative was evaluated to comply with requirements of the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA).

RESULTS OF THE ANALYSIS

The candidate systems were analyzed in terms of quantitative factors such as costs, energy use, land requirements, and net air emissions. A preliminary evaluation of qualitative factors was also conducted which included environmental concerns, implementability, public health impacts, reliability, flexibility, land availability, land use effects, social concerns, and political constraints. Numerous conclusions and recommendations were drawn from the analysis. For a more complete description of results, the reader is referred to references 1 and 2.

As a result of the analysis, a number of options were deferred from further consideration as shown below. The basis for deferral is shown in each case. The Fundamental Sludge Management Alternatives were formulated from concepts embodied in the remaining Candidate Systems.

CANDIDATE SYSTEMS OR PERMUTATIONS DEFERRED AS A RESULT OF THE ANALYSIS OF CANDIDATE SYSTEMS

<u>CANDIDATE SYSTEM/PERMUTATION</u>	<u>BASIS FOR DEFERRAL</u>
Conventional Incineration (Candidate System 1)	Long history of opposition to conventional burning. Newer pyrolytic and starved air systems offer potential advantages in public acceptability and reduced air emissions.
B.E.S.T. Dehydration Process (Candidate System 6)	Process has not been demonstrated on a full scale basis. Other competing processes are more technically advanced.
Remote Mechanical Dewatering for Landfill or Agriculture (Candidate System 11)	Originally deferred because of centrate handling problems and projected lower cost for solar drying basins. Later reinstated as a permutation of the Long Distance Transport Sludge Management Alternative which overcame the centrate handling problem.
Exportation (Candidate System 16)	Backup system would likely be required in the event of market breakdown. Implementation would be difficult due to need for foreign negotiations. Subsequent study conclude that exportation would not be attractive because of projected high costs and the large volume of liquid sludge which would mandate the use of cargo tankage.
Wet Air Oxidation (Candidate System 17)	Older systems have demonstrated a poor record of reliability. Development and marketing of newer systems which offered potential for overcoming past problems was discontinued. Cost analysis indicated that the process is not as cost effective as other more reliable processes. Another new concept for wet air oxidation has recently been developed which conceptually is very attractive. However, the system has only been demonstrated on a pilot scale basis.

Land Improvement-Land Reclamation
(a Permutation of several Candidate
Systems)

Available sites for significant land improvement are limited. The initiative and the deciding factor would be in the hands of the various governmental agencies which have jurisdiction over the proposed areas. The possibility of soil reclamation on San Clemente Island was also deferred due to insufficient land availability.

Rail or Truck Transport of
Dewatered Cake to Agricultural Areas
(Permutation of Candidate System 8)

Both transport options are considerably more expensive and consume more energy than truck transport to in-basin landfills. They are also more expensive than pipeline transport options.

Ocean Disposal of Dewatered or Composted
Sludge (Permutation of Candidate System 15)

Once dewatering or composting is accomplished, other disposal alternatives are equally attractive. Limited dewatering to thicken sludge prior to barging was still considered.

FUNDAMENTAL SLUDGE MANAGEMENT ALTERNATIVES

FUNDAMENTAL SLUDGE MANAGEMENT ALTERNATIVES

Quantitative and qualitative factors analyzed for each of the eighteen candidate systems formed the basis for development of the sludge management alternatives. Primary attention of that analysis was focused on the factors of economics, energy consumption, implementability, and reliability. The reasons for this emphasis were as follows:

- The procedure for development of the candidate systems was designed to eliminate systems which were judged to have obvious and significant adverse social or environmental effects.
- The evaluation of environmental and social factors during the analysis of candidate systems was largely qualitative in nature and not sufficiently detailed to support judgments as to elimination of systems.
- Distinctions between candidate systems on the basis of economics, energy, implementability, and reliability were sufficiently well defined to allow formulation of sludge management alternatives based primarily on consideration of those factors.
- Environmental and social factors of each of the sludge management alternatives were to be evaluated in detail during the remainder of the Project; thus, any significant effects associated with these factors would be identified in subsequent analysis.

DESCRIPTION OF THE FUNDAMENTAL SLUDGE MANAGEMENT ALTERNATIVES

Concepts embodied in the remaining Candidate Systems were formulated into six Fundamental Sludge Management Alternatives (SMA's). Each alternative represented a concept or idea for sludge management distinctly different from the other alternatives. The six alternatives are listed below:

Alternative 1	-	Long Distance Transport
Alternative 2	-	Composting-Sludge Recycle Center
Alternative 3	-	Thermal Processing
Alternative 4	-	Disposal
Alternative 5	-	Separate Secondary Sludge Processing
Alternative 6	-	Baseline "No Project" Alternative

Process flow diagrams for each SMA and its permutations are shown in Appendix C.

SMA 1 - Long Distance Transport

Alternative 1 was composed of all or parts of elements taken from the following candidate systems:

Candidate System 10	-	Evaporation Ponds
Candidate System 12	-	Liquid Sludge for Agriculture
Candidate System 13	-	Solar Drying on San Clemente Island
Candidate System 9	-	Sludge Recycle Center
Candidate System 14	-	Thermal Pretreatment-Anaerobic Digestion

The common element of SMA 1 is that sludge would be transported outside the urban area and either solar dried or used in a liquid form.

A process diagram for Management Alternative 1 is presented in Appendix C. Secondary sludge would be thickened by dissolved air flotation, blended with primary sludge, and anaerobically digested to stabilize the sludge and recover methane gas as an energy source for in-plant needs. Thermal pretreatment may be utilized as deemed appropriate to pasteurize the sludge and improve dewatering properties. Liquid digested sludge would then be transported outside the urban area via pipeline or barge to a site for solar drying, dedicated land disposal, or liquid sludge use in agriculture. Based on the Candidate System analysis, pipeline transport is the most cost effective transport option for liquid sludge conveyed to the desert areas surrounding the LA/OMA area. Barge transport is the only transport option for the case where San Clemente Island is the site for solar drying.

The Candidate System Analysis indicated that agricultural reuse of either liquid or dried sludge may be feasible in some areas if an irrigation water supply can be found. Therefore, the possibility of piping either primary or secondary effluent as a supplemental water supply was investigated.

Evaporation in ponds or drying beds is an attractive dewatering system, particularly in Southern California, since solar energy is used in the drying and no mechanical dewatering systems are required. Sludge which is solar dried would be available for reuse in the desert and agricultural areas or, in the case of San Clemente Island, transported back to the mainland for urban reuse. In all cases, sludge which could not be reused would have to be disposed in a landfill or by other acceptable means.

Subsequent to initial formulation of SMA 1, an option was added to thermally process the solar dried sludge in the desert area. This would allow additional energy recovery from the dried sludge.

SMA 2 - Composting-Sludge Recycle Center

Sludge Management Alternative 2 was composed of all or parts of elements taken from the following candidate systems:

Candidate System 4	-	Co-Pyrolysis with Refuse
Candidate System 8	-	Dewatering for Landfill or Agriculture
Candidate System 9	-	Sludge Recycle Center
Candidate System 11	-	Remote Dewatering for Landfill or Agriculture
Candidate System 14	-	Thermal Pretreatment-Anaerobic Digestion

The common element of SMA 2 is that sludge would be composted and reused as a soil amendment. A process diagram for Management Alternative 2 is presented in Appendix C. Secondary sludge would be dissolved air thickened, blended with primary sludge, and anaerobically digested. Thermal pretreatment may be employed, if appropriate, to pasteurize the sludge and improve dewatering properties. Alternatively, secondary sludge may be processed separately according to one of the process diagrams shown under Management Alternative 5.

Following anaerobic digestion the sludge would be chemically conditioned, dewatered, and composted. Initially, both windrow and enclosed composting were considered. For composting at individual plants, it was later concluded that only an enclosed compost system would be acceptable due to concern over odors, land requirements and wet weather operation. Sufficient acreage to compost all sludge may not be available at the treatment plants after implementation of full secondary treatment. Therefore, the possibility of purchasing sufficient land to locate both the dewatering and composting facilities in a centralized location was considered.

Whether the processing is conducted in centralized facilities or at the treatment plants, the composted product would be marketed via the sludge recycle center concept. Because of limitations imposed by transportation costs, major markets for the material were expected to be in the urban area. Low rate agricultural use might still be a possibility, however. Compost which could not be marketed would be disposed at a landfill or other solid waste disposal facility.

SMA 3 - Thermal Processing

Alternative 3 is composed of all or parts of elements taken from the following candidate systems:

Candidate System 2	-	Pyrolysis
Candidate System 5	-	Active Char Process
Candidate System 7	-	Carver-Greenfield Process

A process diagram for Management Alternative 3 is presented in Appendix C. Secondary sludge would be dissolved air thickened, blended with primary sludge, and either anaerobically digested or thermally conditioned. Alternatively, secondary sludge may be processed separately according to one of the process diagrams shown under Management Alternative 5.

Following anaerobic digestion, or thermal conditioning, sludge would be mechanically dewatered. Dewatered cake would be directly pyrolyzed, blended with RDF as a supplemental fuel and pyrolyzed, or dehydrated and pyrolyzed. Char produced during the pyrolysis may have use in the treatment plant as an activated carbon. Even if the char is reused, some will have to be continually removed to prevent buildup of ash within the process. Ash material would be disposed at a landfill or by other acceptable methods.

Potential energy recoveries from thermal processing were examined. Possible recoveries included preheat of combustion air to the process, production of steam for electrical power generation, and production of pyrolytic fuels to offset in-plant power demands.

Management Alternative 3 would be conducted separately at the three major treatment facilities. Each plant is of sufficient size that maximum economics of scale could be realized. A regional facility was considered more costly because of the added transportation element needed to deliver sludge to the regional site. Therefore, there did not appear to be any need for a regional facility processing the total sludge output at that time. (A regional thermal processing concept was later considered as part of the Alternative Sludge Management Projects due to subsequent developments relating to improved prospects for co-disposal with dairy wastes).

SMA 4 - Disposal

Sludge Management Alternative 4 was composed of all or parts of elements taken from Candidate System 15 - Ocean Disposal. It was later expanded to include elements from Candidate System 8 - Dewatering for Landfill or Agriculture.

The common element of SMA 4 is that digested sludge would be disposed with no further resource recovery beyond use of the digester gas. Two options were considered; landfill disposal of digested, dewatered cake at solid waste disposal facilities and ocean disposal of liquid, digested sludge. In the case of landfill disposal, it should be noted that possibilities for enhanced landfill gas production as a result of moisture, nutrient, alkalinity, and organic addition from the sludge were realized during subsequent analysis. If additional gas production is realized and if the gas is collected for use, landfill disposal could be viewed as a method for resource recovery. At this point in time, however, it was viewed as a disposal option.

In 1972, the State Water Resources Control Board adopted the "Water Quality Control Plan for Ocean Waters of California". The Ocean Plan contains a prohibition of ocean disposal of sewage sludge. Furthermore, the "Federal Water Pollution Control Act Amendments of 1972" contain a requirement in Section 301 that effluent discharged from publicly owned treatment works must achieve effluent limitations based upon secondary treatment. Discharge of treated or untreated sludge which has been separated from the main sewage stream will not meet that requirement. Since EPA is prohibited from using grant monies to fund any project which will not achieve such effluent limitations, no grant funds were authorized to study alternative ocean disposal practices.

It was felt, however, that a long range planning study, such as the LA/OMA Project, should examine all feasible reuse and disposal alternatives and that the Project should not be constrained to examine only the land and air environments as ultimate repositories for waste material to the exclusion of the water environment. Furthermore, the economic, environmental, and social costs of all alternatives should be documented so that society understands the total cost of the decisions which must be made regarding sludge management. Thus, to assure that all sludge management alternatives were investigated, the local operating agencies, the Los Angeles County Sanitation Districts, the City of Los Angeles, and the Orange County Sanitation Districts, provided separate funds for the study of ocean disposal alternatives.

A process diagram of the ocean disposal options is presented in Appendix C. Secondary sludge would be dissolved air thickened, blended with primary sludge, both stabilized by anaerobic digestion, and transported for ocean disposal. Two transport options were evaluated, barge and ocean outfall.

SMA 5 - Separate Secondary Sludge Processing

Sludge Management Alternative 5 is composed of all or parts of elements taken from the following candidate systems:

- | | | | |
|------------------|---|---|-------------------------------|
| Candidate System | 2 | - | Pyrolysis |
| Candidate System | 3 | - | Separate WAS Treatment |
| Candidate System | 7 | - | Carver-Greenfield Dehydration |

Candidate System 9	-	Sludge Recycle Center
Candidate System 14	-	Thermal Pretreatment

It had become increasingly apparent that separate processing of secondary or waste activated sludge (WAS) may be desirable for several reasons. First, waste activated sludge adversely affects dewatering properties when blended with primary sludge. This effect had been demonstrated in several studies conducted by the operating agencies of the LA/OMA Project. Second, waste activated sludge has a higher fertilizer value than primary sludge, with nitrogen concentrations generally ranging between 5 and 8 percent. Due to the higher fertilizer value and the potential for increased monetary return on the product, the possibility existed for cost effective processing of WAS by methods which would not be cost effective with primary or combined sludge. Third, interim sludge processing facilities were being designed, in most cases, to process primary digested sludge. Large expenditures to process WAS had generally not been committed. Therefore, alternative processing modes might be more attractive since existing facilities need not be credited in the economic analysis.

The advantages of separate secondary sludge processing are most readily applied to Management Alternative 2, Composting, and Management Alternative 3, Thermal Processing. Both alternatives use mechanical dewatering and potential capital and operating cost reductions might be realized by separate WAS processing. Therefore, it was assumed that separate secondary sludge processing would only be applicable if Management Alternatives 2 or 3 were implemented.

A number of separate options to process waste activated sludge have been identified. Each option is considered to be technically practical and, in addition, contains elements particularly attractive to the LA/OMA study area. Process diagrams for all options are presented in Appendix C.

SMA 6 - Baseline "No Project" Alternative

The National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA) require that a "no project" alternative be included as part of any long range, facilities planning. The intent of this requirement is two-fold: (1) to provide a baseline case from which to measure the economic, environmental, and other impacts of the alternative projects; and (2) to determine the impacts if no projects were implemented.

Applying the "no project" concept to the LA/OMA study was complicated by the fact that interim solids processing facilities were being designed and constructed by the operating agencies. Secondary treatment facilities were also being designed and, in some cases, construction had commenced. Clearly, the term "no project" did not strictly apply in the case of the LA/OMA study since many projects which produce sludge, and others which process it, were currently being implemented. The term "baseline" alternative was considered more applicable since this alternative will serve as a baseline case from which to measure economics and other impacts of alternative sludge management plans.

Based upon these considerations, the baseline alternative was defined as follows:

"For purpose of comparison, the baseline alternative will assume full secondary treatment to be implemented in stages on or before 1983. Credit will be given for all primary and waste activated solids processing facilities in place, under construction, or contracted for construction as of December, 1978. Sludges beyond those which can be processed in the latter facilities will be assumed to be discharged through existing outfall facilities for ocean disposal."

A process diagram for the baseline alternative is presented in Appendix C. Anaerobic digestion would continue to be used for sludge stabilization. Digested sludge would then be chemically conditioned, centrifuge dewatered, composted and landfilled. Marketing of compost product would continue in those cases where marketing is currently practiced. Digested sludge loads above the baseline dewatering capacity were assumed to be discharged to the ocean through existing ocean outfalls. Dewatered cake loads in excess of the baseline compost capacity were assumed to be truck hauled to existing landfills for disposal.

RESULTS OF THE ANALYSIS

Based on the concepts embodied in each Management Alternative, detailed permutations of each management alternative were developed. A total of 45 permutations were initially developed. In most cases, the differences between permutations were technical in nature. Because of the large number of permutations, a second screening was conducted to eliminate those which were less viable from a technical standpoint. Options deferred as a result of this additional screening are described below.

PERMUTATIONS DEFERRED DURING ANALYSIS OF THE SLUDGE MANAGEMENT ALTERNATIVES

<u>PERMUTATION</u>	<u>BASIS FOR DEFERRAL</u>
Windrow Composting at Individual Plants (SMA 2)	For composting at individual plants, it was concluded that only an enclosed composting system would be acceptable due to concern over odors, land requirements, and wet weather operation.
Solar Drying on San Clemente Island (SMA 1)	Further site evaluation indicated a lack of suitable land for construction of solar drying basins.
Liquid sludge Use in Agriculture (SMA 1)	Land requirements for use of liquid sludge in agriculture are projected to be considerably greater than for use of dried, composted sludge. Based on reduced land requirements, greater ease of operations, and negligible benefits from sludge derived water, agricultural use was limited to dried or composted sludge.
Dedicated Land Disposal of Liquid Sludge (SMA 1)	This would involve the commitment of more land for disposal compared to stockpiling of dry sludge. In addition, future use of the land for agriculture would probably be precluded.

Commercial Agricultural Use

Total reuse in the agricultural areas was not considered likely since only Imperial and Southern San Joaquin Valley have sufficient acreage to accommodate the total sludge production. Limited reuse of sludge in commercial agriculture, via the sludge recycle center concept, has not been ruled out.

Thermal Pretreatment Prior to Pipeline Transport (SMA 1)

The need for heat pasteurization to pipelining was not demonstrated. The need for low temperature heat pasteurization was later reevaluated due to public concern over the possibility of wind blown pathogens.

Use of Pyrolysis Char in the Wastewater Treatment Process (SMA 3)

Use of pyrolysis char for adsorption of organics offers several potential benefits in terms of wastewater treatment. However, the decision to implement such a system should be based primarily on wastewater treatment needs. A conservative approach was adopted that assumed all pyrolysis char to be landfilled.

Separate Pipeline Transport of WAS to Desert Areas (SMA 5)

It was considered unlikely that any agency would make the effort necessary to implement such a system and not design to handle the entire sludge flow.

Thermal Pretreatment prior to Thermal Processing (SMA 3)

A decision was made to use conventional thermal conditioning ahead of thermal processing due to the increased cake solids expected from dewatering and the importance of the latter in a thermal processing system.

Due to the deferrment of less viable permutations and certain minor organizations the total number of permutations under consideration was reduced to about 27. However, many of the permutations were evaluated under different case conditions, and the total number of cases studied totalled about 44, and many of these were evaluated at each of the three treatment facilities.

At this point in the process, detailed design criteria had been developed for each unit process and a computer program written to assist in the analysis. The computer program allowed detailed mass and energy balances to be conducted for each unit process in the treatment train. A description of the program capabilities is provided in Appendix B.

The economics, energy balance, and land use of each unit process could then be considered in much greater detail compared to the analysis of candidate systems. During this same period, efforts intensified to develop improved air emission factors compared to those used in the analysis of candidate systems. The development of these analytical tools was a major accomplishment which coordinated well with the increased degree of definition afforded the Management Alternatives as a result of the screening process.

The Fundamental Sludge Management Alternatives and their permutations (see Appendix C for process flow diagrams) were analyzed in detail.

A summary of results was compiled and presented to the LA/OMA Policy Board for review (7). Based on this analysis the following permutations were deferred from further consideration.

PERMUTATIONS DEFERRED AS A RESULT OF THE
ANALYSIS OF THE SLUDGE MANAGEMENT ALTERNATIVES

PERMUTATION	BASIS FOR DEFERRAL
Agency Controlled Agricultural Use (SMA 1)	Assuming secondary effluent would have to be supplied for irrigation requirements, the projected net system cost was nearly 3 times that of the least cost alternatives. Credits from sale of crops were almost negligible compared to the projected annual capital and O & M. Secondary effluent pumping represented a large energy consumption.
Thermal Pretreatment of Combined Sludge Prior to Composting (SMA 2)	System did not appear to be economically attractive when compared to other in-plant composting alternatives. There is a lack of information regarding odor destruction during composting of a heat treated combined sludge.
Regional solar drying at in-basin site. (SMA 2)	Deferred for apparent lack of available land.
Centrifuge Dewatering (A permutation of several SMA's)	Based upon information available at that time, belt press devices were projected to be more cost effective when enclosed composting or thermal processing is used downstream of dewatering. Centrifuge dewatering was, in general, less expensive when preceding windrow composting or landfilling. In either case, the cost differences were less than \$4/ton. Belt presses were assumed in subsequent studies for purposes of cost estimation. (Note that this was not a design decision and later data indicated a very close comparison between the two dewatering systems).

**DEVELOPMENT OF THE ALTERNATIVE
SLUDGE MANAGEMENT PROJECTS**

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DEVELOPMENT OF THE ALTERNATIVE SLUDGE MANAGEMENT PROJECTS

Concurrent with evaluation of the Fundamental Sludge Management Alternatives, a regional environmental evaluation was conducted for the purpose of identifying and screening potentially suitable sites for sludge facilities. A summary of that work will be presented later in this chapter. The point is that efforts were being made to reduce the number of alternative process trains as well as the number of alternative process sites. The goal was to identify a single process train tied to specific sites and transportation routes. This effort culminated in the definition of Alternative Sludge Management Projects which will be described in Chapter III.

Before a single process train could be selected for each Project, it was necessary to conduct one final screening. Both qualitative and quantitative factors were considered in this evaluation. For further information the reader is referred to Ref. 8. Those options deferred from further consideration and the basis for deferral are summarized below. The recommendations are given in two parts. Options in the first group were recommended for deferral from further detailed evaluation. Options in the second group were also recommended for deferral and would not be considered further unless needed to mitigate features or elements of the recommended project. For example, it was intended that no further consideration be given to mechanical dewatering at desert locations unless severe objections were raised regarding use of large amounts of land for solar drying. If substitution of mechanical dewatering resulted in an acceptable project, such substitution would be made. Process trains for the Alternative Sludge Management Projects were formulated from processes remaining after this final screening.

OPTIONS DEFERRED AS A RESULT OF THE ANALYSIS OF PERMUTATIONS AVAILABLE FOR DEVELOPMENT OF THE SLUDGE MANAGEMENT PROJECTS

BASIS FOR DEFERRAL

- Deferred from further detailed evaluation:

Thermal Conditioning and Thermal Pretreatment

Both systems offer considerable potential for dewatering of waste activated sludge (WAS). However, concerns over odors and mechanical complexity were not sufficiently resolved. In all cases, a dehydration system was cost competitive, operated with lower temperature and pressure reactors, and had less odor potential. In general, the thermal conditioning and thermal pretreatment systems were deferred in favor of dehydration technology.

Dehydration of WAS only

The reliability of dewatering of separate WAS is a major concern in dehydration of WAS. Cake solids is a major factor in determining the cost of dehydration. Limited field data on the belt press dewatering of separate WAS indicated a relatively higher cake solids (= 18%) but very poor solids capture (= 70%). Use of other dewatering devices, e.g. centrifuges, would provide higher solids capture (90%+) but poor cake solids (= 10%).

However, field tests on belt press dewatering of combined sludges consistently indicated good solids capture (90%+) and drier cake (25%+). For reliable and efficient dewatering and dehydration, combined sludges appeared to have potential advantages over separate WAS. Dehydration of separate WAS was therefore deferred from further evaluation.

Thermal Processing of Dewatered Sludge and Dairy Waste

Thermal processing in an autogenous mode cannot be achieved based on the quantity and characteristics of manure available in the Chino Basin.

Thermal Processing of Steam Dried Dewatered Sludge and Refuse

Indications are that sludge should be dried prior to mixing with solid waste and introduction to a vertical shaft reactor (VSR). Dehydration was selected as the mode of drying because of cost and energy considerations. If VSR is selected for thermal processing steam dryers could then be considered as an alternative to dehydration to alleviate concerns with dehydration complexities.

- Deferred unless most viable option must be changed or mitigated.

Indirect Steam Drying

Indirect steam dryers have comparable capital costs to the dehydration systems. However, energy requirements are considerably greater. The process was being deferred in favor of the more energy efficient CG process. If complexity of dehydration becomes an overriding concern, the steam dryers could be reconsidered as, perhaps, a less complex system in projects where energy recovery from dry solids is included.

Pasteurization

A number of sludge pasteurization processes were examined including heat, electron beam and gamma ray processes. These processes, while effective, add cost and complexity to the system. A decision was made to rely on composting alone to achieve a pathogen-free product for reuse. If this was shown to be unacceptable at some future date, these processes could be re-evaluated.

Enclosed Composting at Regional Sites

Enclosed mechanical composting is more expensive than the windrow system but offers potentially better control of odors and dusts, and less susceptibility to wet weather. The windrow system will be assumed unless site specific factors require increased mitigation of odors, dusts or other factors.

Vertical Shaft Reactor (VSR)

Analysis indicated that the Multiple Hearth Furnace (MHF) system was less expensive than the vertical shaft reactor for gasification of sludge and refuse. Potential advantages of a slagging VSR include production of a more stable inert material and production of a fuel gas which might require reduced air tradeoffs for implementation. If these factors become significant, the slagging VSR could be re-evaluated.

Mechanical Dewatering at the Desert Site

Compared with solar drying basins, mechanical dewatering was less capital-intensive, but considerably more expensive in terms of O & M and total costs. It also produced less available electricity, consumed more diesel fuel, required more skilled manpower, was more complex and less flexible to operational and wasteload changes. The major advantage of mechanical dewatering was the reduced land requirement compared to solar drying beds.

Composting or Drying to Achieve a 50 Percent Blend Prior to Landfilling

State guidelines on landfilling of sludge require leachate control systems at Class II sites if the moisture content of sludge exceeds 50 percent. It appears that leachate control facilities can be implemented at certain landfills. Composting or drying to achieve a 50 percent blend is more costly than direct landfilling at today's costs. However, these options can be reconsidered if direct landfilling should become unattractive due to inability to construct leachate control facilities, regulatory prohibitions, economic conditions or other factors. (Note that landfills in the jurisdiction of the Santa Ana RWQCB are required to achieve a 50 percent blend)

Mechanical Composting of Combined Sludge

Feed moisture content has a profound impact on the composting process. Dewatering combined sludge does not produce as dry a cake as obtained from dewatering of primary sludge only. The characteristics of combined sludge may fluctuate due to the varying nature of WAS. This may affect the dewatering characteristics of combined sludge with concomitant impact on the composting process. Such uncertainty could be avoided by drying a portion of the dewatered sludge prior to composting.

Apart from efficient feed moisture control, drying would facilitate uniform composting operation, promote efficient solids and pathogen destruction, provide a more uniform product and require less land at the treatment plants, thereby providing more room for expansion of wastewater treatment facilities.

(Note that later analysis indicated that composting could be conducted without prior drying. Demonstration projects of sludge composting without prior drying are included as part of the proposed Sludge Management Program.)

Thermal Processing of Dehydrated Sludge and Refuse

Addition of refuse to dried sludge prior to thermal processing may provide additional cost and energy benefits over burning dried sludge by itself (3S1). Such an option could increase financial return from codisposal with refuse and provide flexibility to accept reduced amounts of refuse below that required for autogenous combustion. However, the complexity of the dehydration process would have to be accepted. A decision was made to consider only dewatered cake addition with refuse since combustion of dried sludge was considered elsewhere. (3S1)

SITE IDENTIFICATION STUDIES

SITE IDENTIFICATION STUDIES

In order to conduct a detailed analysis of the Alternative Sludge Management Projects and for purposes of the environmental assessment of alternatives, it was necessary that sites be identified for the processing and ultimate disposal of sludge residuals. A systematic procedure for site identification was developed. Criteria for site selection and screening were developed at the beginning of the process to provide an objective and impartial evaluation of alternative sites. A large portion of the Southern California area, including desert areas surrounding the metropolitan area, were considered at the beginning of the study. As the process continued, certain areas were deferred from further consideration and potentially suitable lands identified in others. Additional screening criteria were then used to identify the more acceptable sites from those considered to be potentially suitable. Site surveys and application of yet additional criteria resulted in the selection of a primary processing and ultimate disposal sites for each sludge management project under consideration.

Purpose of this section is to present the process and criteria used in selecting the recommended sites. Due to the scope of such an undertaking, and the large budget and manpower expended to assure adequate site selection, only a brief summary and overview can be presented here. For further information, the reader is referred to references cited at the end of this chapter.

PRELIMINARY SITES STUDIES

The LA/OMA Phase I Report (Ref. 9) defined as Element 8.1 an investigation to gather available information on potential sites for sludge application or disposal to the land. A preliminary effort in this regard was conducted as part of the analysis of candidate systems.

The boundary of the LA/OMA Study Area extended north from the Oxnard Plain in Ventura County to the southern portion of San Joaquin Valley, east across the Mojave Desert, south to the Imperial Valley, and west to the sea, encompassing all of Los Angeles and Orange Counties and parts of Ventura, Riverside, and San Bernardino Counties. The specific areas under investigation were:

- LA/OMA Urban Area (Los Angeles and Orange Counties)
- Antelope Valley and Victor Valley (Mojave River Valley)
- Coachella Valley
- Imperial Valley
- San Clemente Island (north end)
- South San Joaquin Valley (south of Bakersfield)
- Southwestern San Bernardino County (Chino Basin)
- Ventura County (Santa Clara River Basin and Oxnard Plain)
- Western Riverside County (Perris Valley region)

These areas were surveyed for potential sites for the following uses: landfills, lands dedicated to sludge disposal, lands suitable for low and high-rate agricultural reuse, desert land improvement, and land reclamation. Results are presented in Ref. 1.

Based on information gathered during analysis of candidate systems and the preliminary site investigations, the various reuse and land disposal options were reviewed along with the candidate areas. As a result, a number of reuse options were deferred as described previously in this chapter. A number of candidate areas were also deferred from further consideration as shown in Table II-2. Major results of this evaluation are summarized below. Further details of the analysis are presented in Ref. 10 and 11.

- Antelope Valley offered the highest potential for solar drying beds and particularly an agency-controlled agricultural operation. The area was recommended for further investigation.
- Although distance was a constraining factor, some of the characteristics near Harper Lake in Victor Valley were comparable to the Antelope Valley. It was recommended that the area be included with Antelope Valley for further investigation.
- South San Joaquin Valley was comparable to the Antelope Valley in terms of implementability, costs, and energy considerations. The area was recommended for further investigation.
- Western Riverside County, which is proximate to the LA/OMA Urban Area, was determined to have a good potential for solar drying beds and agency-controlled agricultural reuse. The area was recommended for further investigation.
- Although not evaluated in detail, there appeared to be some vacant and undeveloped land within the Chino Basin of Southwestern San Bernardino County. It was recommended that the area be included with Western Riverside County for further investigation.
- The primary uncertainty with Coachella Valley was the availability of suitable land that would be compatible with large scale sludge reuse. It was recommended that consideration of the area be deferred, pending the investigation of other more feasible areas.
- The Imperial Valley was the most remote and expensive area in terms of delivery costs. It was recommended that consideration of the area be deferred.
- With the high cost for transportation, construction costs and problems, and the severe limitation of available land, San Clemente Island did not appear feasible. It was recommended that consideration of the area be deferred.
- Due to the residential patterns and limited availability of land in Ventura County, it was recommended that consideration of the area be deferred.

REGIONAL ENVIRONMENTAL EVALUATION

The objective of the Regional Environmental Evaluation was to identify for future more detailed investigation those parcels of land potentially suitable for the various sludge processing, reuse, and land disposal options being considered in the LA/OMA Project.

TABLE II-2
RESULTS OF PRELIMINARY SITE EVALUATION IN THE VARIOUS AREAS

	EVAPORATION BASIN	COMPOSTING AREA	HIGH RATE SLUDGE FARM	LANDFILL	CENTRALIZED PROCESSING FACILITIES
<u>Recommended for Detailed Study</u>					
Antelope Valley and Victor Valley	X	X	X	X	
S. San Joaquin Valley	X	X	X	X	
Western Riverside County and S.W. San Bernardino County	X	X		X	
LA/DNA Area	X	X		X	X
<u>Not Recommended for Further Consideration</u>					
Coachella Valley	X	X		X	
San Clemente Island	X	X			
Imperial Valley	X	X	X	X	
Ventura County					
(Santa Clara River Basin)	X	X	X		

Areas retained for further investigation, collectively designated as the Regional Planning area, consisted of areas which passed the screening criteria of the preliminary studies. They were grouped into five individual Project Areas defined as follows:

- South Los Angeles County
- Orange County
- Southwestern San Bernardino/Western Riverside Counties
- Antelope/Victor Valley
- South San Joaquin Valley

Each Project Area was defined by political boundaries and/or drainage divides established by the California Department of Water Resources. Drainage divides, which separated the Regional Planning Area into discrete hydrologic units, were selected wherever possible, since they tended to correspond with other significant environmental considerations. Major hydrologic units were used except in instances where they encompassed too extensive an area. In these cases, smaller hydrologic subunits and/or political boundaries were selected. In one instance - the southeastern portion of Orange County - the political boundary was chosen instead of the drainage divide in order to include all of the area under investigation.

South Los Angeles County and Orange County were generally defined by political boundaries. The northeastern portion of South Los Angeles County, however, shared a drainage divide with Antelope/Victor Valley, an area entirely corresponding to a major hydrologic unit. Southwestern San Bernardino/Western Riverside Counties was defined by both drainage and political boundaries. The South San Joaquin Valley was also defined by a composite boundary. Because of the absence of a subhydrologic unit in the vicinity of Bakersfield, however, the entire area north to the county line was included in the Regional Environmental Evaluation.

The evaluation process consisted of the following four studies, the first of which was performed principally by the LA/OMA Project staff during initial stages of the evaluation.

- Viable sludge processing, reuse, and land disposal options were identified together, with related requirements and the specific areas to be evaluated.
- Parcels of land that could potentially be used were identified throughout the 12,000 square miles under investigation.
- Environmental factors protected by federal and state legislation and/or regulations were identified as potential constraints to the use of identified parcels of land.
- Identified parcels of land were initially screened in terms of these legal, and regulatory environmental constraints and finally in terms of probable conflicts with adjacent land uses.

Major results of the Regional Environmental Evaluation are outlined below.

- Although only the most basic environmental restrictions were considered in the Regional Environmental Evaluation, their use significantly reduced the number of parcels of land that were available for future, more detailed investigation. This was particularly true in urban areas where there were relatively few means of adequately mitigating conflicts with adjacent land uses.

- The distribution ranges of the state and federally protected California Condor and the San Joaquin Kit Fox extended over so much of the South San Joaquin Valley that consideration of the entire area was deferred.
- In South Los Angeles County only a few, small noncontiguous parcels of land were identified for future investigation. The range of processing and reuse options initially considered for the Hyperion Treatment Plant was reduced accordingly. Options available to the Joint Water Pollution Control Plant, however, remained somewhat more flexible.
- Significantly more and larger parcels of land were identified for future investigation in Orange County, particularly in the central and southeastern portions. All of the processing and reuse options remained available to the Orange County Sanitation District treatment plants.
- A relatively large number of sizable parcels of land were identified for future investigation in Southwestern San Bernardino/Western Riverside Counties. In terms of urbanization and thus the availability of land, the area represented a midpoint between the more developed coastal sections and the less populated desert regions.
- The largest amount of land was identified in Antelope/Victor Valley. Due principally to the rural nature of the area, essentially one, very large, contiguous parcel remained for future investigation.

In terms of the total area included in the Regional Environmental Evaluation, however, a substantial number of parcels were identified for future, more detailed investigation. All of the sludge processing, reuse, and land disposal options were also still viable, although they were no longer considered equally practicable for all of the treatment plants.

FINAL SITE SELECTION PROCESS

Further refinement of areas listed as Potentially Suitable Land (PSL) during the Regional Evaluation process was accomplished by (1) obtaining new information about each of the remaining sites, (2) reassessing and/or refining previously collected data, and (3) updating information used during the Regional Environmental Evaluation.

County planning departments in each of the Long-Distance Transport Areas were contacted to obtain information about recent development management plans, and items of significant controversy that might affect the potential for use of a site, such as a history of significant water quality problems. Similar information was sought from the Bureau of Land Management about lands under their jurisdiction, and from Irvine Company planners about land owned by the Irvine Company.

A review of lands identified as Good and Fair was then made, together with a review of the information obtained from the planning offices. On the basis of this review, PSL's that were initially rated Fair but which obviously offered little potential for project use were eliminated from further consideration. These included small isolated parcels in the Urban Areas that were long distances

from the treatment plants, and parcels to which access was very restricted. Also, included were sites with multiple geohydrological constraints that, when considered together, presented a more serious hazard than the noncumulative Fair rating indicated.

Site visits were made to each parcel of land identified during the initial review. A primary purpose of these visits was to determine where development had occurred since the generation of the land use information. The visits also provided information about topography, ecological sensitivity, adjacent land use, access, visibility, and in some cases, ownership. In the case of the Antelope/Victor Valley area, overflights were made of these sites. Much of the same information was obtained.

Major results of the screening effort are outlined as follows.

- South Los Angeles County

Except for land within the JWPCP boundaries in Carson and the Hyperion boundaries in El Segundo, all land that was being considered in South Los Angeles County was eliminated during the screening process. Most of this land was eliminated on the basis of potential adjacent land use conflicts with other areas eliminated because of existing development plans.

- Orange County

Adjacent use conflicts eliminated most Potentially Suitable Land in Orange County. In addition, some land was eliminated because its slope exceeded 15 percent. This land was originally included because of difficulties encountered in interpreting the slope information used for preparing the base map.

Much land in the Irvine area was eliminated because of susceptibility to urban encroachment, existing development plans, adjacent land use, or because of its inclusion in the agricultural preserve established by the Williamson Act. Procedures exist for taking land out of the preserve for uses beneficial to the community, but the process would probably be lengthy and complicated. Also, much residential development is occurring near these agricultural areas.

Six areas remained in Orange County for further consideration.

- Southwestern San Bernardino/Western Riverside Counties

While a fairly large amount of undeveloped land still remains in the area, development is occurring very rapidly and is scattered throughout those portions of the two counties. Much land was eliminated because it lies in undeveloped islands in areas where rapid urban encroachment is occurring. Existing development plans accounted for the elimination of other land in Southwestern San Bernardino and Western Riverside Counties.

Only one area remained for further consideration, that in the vicinity of the Chino dairy farms. Use of this area would probably involve a cooperative agreement with the dairy farmers for processing of dairy wastes, since disposal of these wastes has become a major problem for the dairy farmers.

- Antelope Valley/Victor Valley

Unlike the other Project Areas, the Antelope/Victor Valley area has large amounts of remaining Potentially Suitable Land. Most of this land is rated Fair, but enough Good acreage remained that the remaining effort for this area focused only on the Good sites.

One area that appeared to offer potential for use was in the northeastern corner of Los Angeles County, adjacent to the southern border of Edwards Air Force Base. A large percentage of the land in this area was rated Good. That portion of the Good area adjacent to Edwards seems best suited to project use. The base provides a buffer to the north. A major advantage to this site is its location in Los Angeles County.

A second promising area was that northwest of Edwards Air Force Base near the city of Mojave. This area is physically similar to the first, but has slightly more irregular terrain, less land rated Good, and is in Kern County. Kern County Planning Department personnel have indicated that there are no significant uses of the area and no known future plans for its use.

A number of Good areas remained in the Victor Valley/Barstow region. These appeared to be significantly less desirable, however, than those farther to the west in the Antelope Valley, particularly the site in Los Angeles County. These eastern areas are much more uneven topographically and have generally steeper slopes. A number of them are easily visible from major highways fully protected by local and state water agencies. They also generally have more diverse biotic communities than the western areas and are more significant ecologically, as well as archaeologically. In addition, land use and population are increasing more rapidly here than in the two areas adjacent to Edwards. This is particularly true between Victorville and Barstow, where a number of the sites are located. Considerable use is made of most of these areas by off-road vehicles and there might be resistance from ORV groups to the loss of this land. A significant advantage to these eastern sites, however, is that substantial portions of their land are in public ownership. Besides these Good areas, two Fair areas were included because they were suggested by BLM personnel as potentially good sites. A total of 8 sites were recommended in the Barstow/Victorville area.

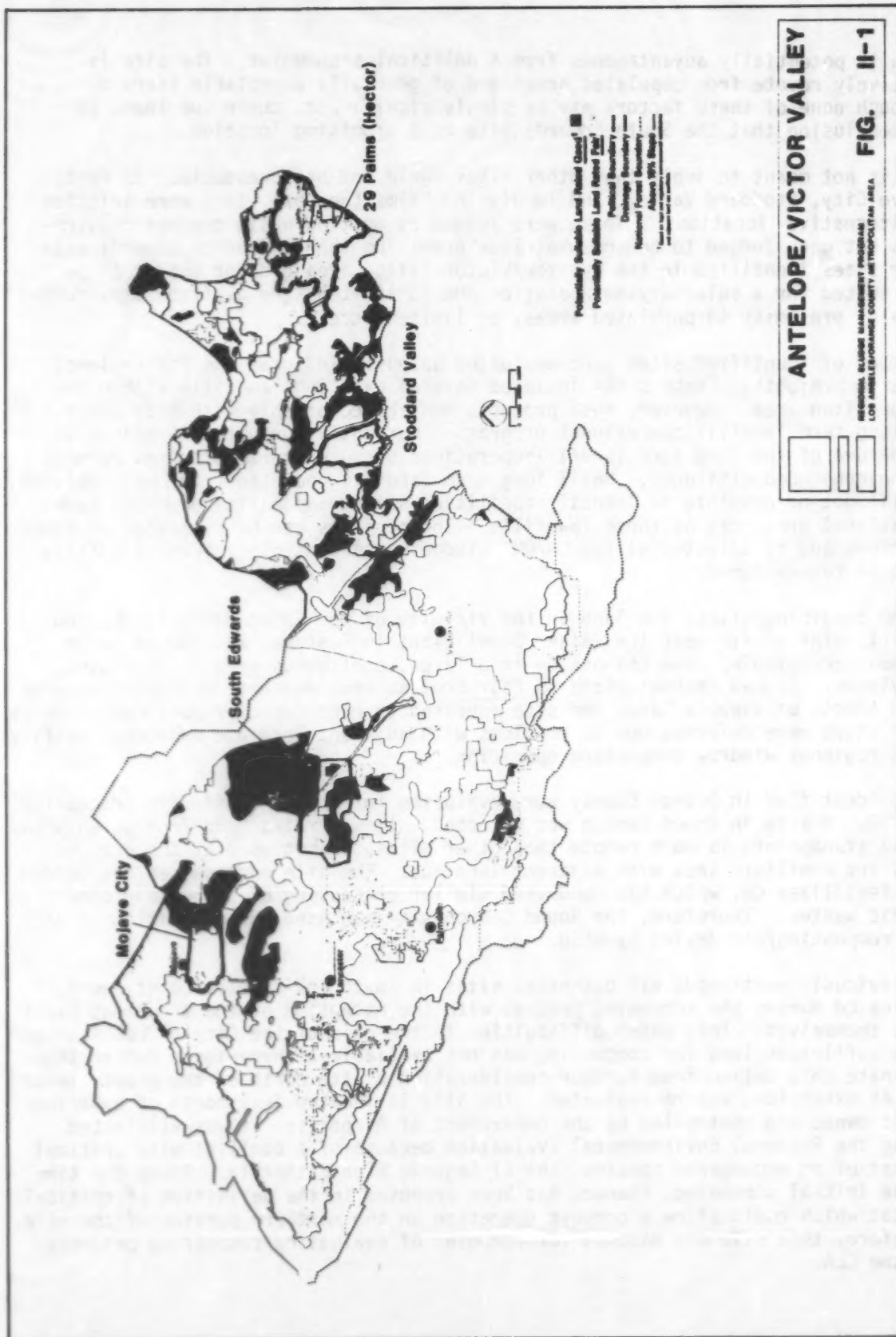
Potential Sites which remained after the above screening were then assessed using basic engineering criteria such as size, slope, general terrain, accessibility, construction effort, and other factors as appropriate. A primary consideration was whether or not the potential site had enough useable land to meet the basic project requirements. Sites under consideration were visited by engineering staff and consultants prior to application of the screening criteria.

Based on this analysis the primary and alternative sites for regional projects shown in Tables II-3 were selected for purposes of project evaluation. The location of desert sites is shown in Figure II-1. The Fontana site is located west of Kaiser Steel and south of the Etiwanda Power Plant near Fontana.

The South Edwards site was selected as the primary site for evaluation of projects located in the desert for a number of reasons. About 19,000 acres of land rated Good are contained within the site. The area is located within Los Angeles County

TABLE II-3
SITES RECOMMENDED FOR ANALYSIS OF REGIONAL PROJECTS

SITE NAME	REGIONAL DESERT PROJECTS		REGIONAL IN-BASIN PROJECTS	
	PRIMARY SITE	ALTERNATE SITE	PRIMARY SITE	ALTERNATE SITE
South Edwards	X			
Mojave City		X		
Stoddard Valley		X		
29 Palms (Hector)		X		
Fontana			X	(no alternate sites evaluated)



ANTELOPE/VICTOR VALLEY

REGIONAL SLUDGE MANAGEMENT PROGRAM
LOS ANGELES/ORANGE COUNTY METROPOLITAN AREA

FIG. II-1

which is potentially advantageous from a political standpoint. The site is relatively remote from populated areas and of generally acceptable terrain. Although none of these factors may be singly significant, their sum leads to the conclusion that the South Edwards site is a promising location.

This is not meant to imply that other sites would not be acceptable. In fact, Mojave City, Stoddard Valley, and Twentynine Palms (Hector) sites were selected as alternative locations. These were judged as meeting basic project requirements but were judged to be somewhat less promising than the South Edwards site. Other sites identified in the Barstow/Victor Valley area did not appear to be well suited for a solar drying operation due to limited land availability, rugged terrain, proximity to populated areas, or limited access.

A number of identified sites were evaluated as possible locations for regional in-basin projects. These sites included several existing landfills within the metropolitan area. However, such projects must be compatible with both short and long term landfill operational programs. Currently, uncertainty exists as to the nature of the long term landfill operations because of need for new permits and neighborhood attitudes. Until long term landfill operations are well defined, it will not be possible to identify facilities siting capability nor long term operational prospects at these landfills. The projects can be evaluated at other locations and if selected as the LA/OMA sludge management plan, these landfills would be reconsidered.

Of the remaining sites, the land in the vicinity of the Chino dairy farms, and in particular a site near the Kaiser Steel Plant in Fontana, was judged to be the most acceptable. The Chino site is a large, contiguous area in the Chino dairylands. It was characterized as Fair from an environmental standpoint. With large tracts of useable land, the site appeared to meet basic project requirements. Other sites were deferred due to problems with adjacent land use and unsuitability for a regional windrow composting operation.

Sites identified in Orange County were evaluated for possible off-site processing by OCSD. A site in Round Canyon was selected. It was rated Good from an environmental standpoint, is more remote than other sites, is not used at the present time, and conflicts less with adjacent land use. The site encompasses the Golden West Fertilizer Co. which has conducted similar processing of sludge and other organic wastes. Therefore, the Round Canyon site was used for evaluation of off-site composting/air drying by OCSD.

As previously mentioned, all potential sites in South Los Angeles County were eliminated during the screening process with the exception of the treatment plant sites themselves. This posed difficulties in the case of the City of Los Angeles since sufficient land for composting was not available at Hyperion. Rather than eliminate this option from further consideration a site north of the plant, termed the LAX extension, was re-evaluated. The site is located just north of Hyperion and is owned and controlled by the Department of Airports. It was eliminated during the Regional Environmental Evaluation because of a conflict with critical habitat of an endangered species, the El Segundo Blue Butterfly. Since the time of the initial screening, changes had been proposed in the definition of critical habitat which could allow a compost operation on the northern portion of the site. Therefore, this site was assumed for purposes of evaluating composting projects for the CLA.

As a result of the site selection process, the following sites were identified as being most suitable for purposes of project analysis:

- Regional Desert Projects - South Edwards site with on-site disposal of residuals.
- Regional In-Basin Projects - Fontana site with disposal of residuals at the Milliken Avenue landfill.
- Individual Agency Projects
 - LACSD - All projects at JWPCP with disposal of residuals at Puente Hills Landfill.
 - CLA - All projects at Hyperion, except composting at the LAX extension, with disposal of residuals at Lopez Canyon landfill.
 - OCSD - All projects at Plants No. 1 and 2, except composting at Round Canyon, with disposal of residuals at Prima Deschecha landfill. For the Round Canyon Project residuals were assumed to be disposed at the proposed Bee Canyon landfill.

These sites were used for analysis of the Alternative Sludge Management Projects described in Chapter III.

**ADDITIONAL INFORMATION RELATING TO
DEVELOPMENT AND ANALYSIS OF THE
SLUDGE MANAGEMENT PROJECTS**

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ADDITIONAL INFORMATION RELATING TO DEVELOPMENT AND ANALYSIS OF THE SLUDGE MANAGEMENT PROJECTS

A number of additional studies were conducted, the information from which was used in formulation and analysis of the Candidate Systems, Fundamental Sludge Management Alternatives, and Alternative Sludge Management Projects. Important among these were demonstration projects conducted by the LA/OMA Project and other special technical studies. The relationship of these studies to development and analysis of the management projects is discussed in the following.

DEMONSTRATION PROJECTS

A number of demonstration projects were sponsored by the LA/OMA Project for purposes of demonstrating new or altered technologies for sludge processing and ultimate disposal, and for the purpose of developing design criteria used in the analysis of management projects. A brief description of the major projects was presented in Chapter 1. Attention will now focus on how results of these projects were used in formulating the sludge management projects.

Agricultural Project

Field and greenhouse studies on land application of sludge were conducted by the University of California at Riverside. Crop response to varying application rates and the potential for uptake of trace metals was determined. Design criteria for land application of sludge and a risk assessment on reuse of sludge based compost were based in part on results of this study.

Thermal Pretreatment Demonstration

A pilot scale demonstration of the concept of heat treatment prior to anaerobic digestion was conducted at JWPCP. Improvements in sludge dewatering, enhancement of gas production from anaerobic digestion, a reduction in odor level of the sludge cake, and improved sidestream characteristic were noted. This information was used in development of design criteria for heat treatment and thermal pretreatment processes.

Mechanical Dewatering Studies

Numerous mechanical dewatering devices were tested on sludges from each operating agency. Mechanical dewatering is a key unit process in many management alternatives and these studies provided sound design criteria for economic analysis.

Carver-Greenfield Dehydration Study

The Carver-Greenfield system is a drying process which can remove water with greater thermal efficiency than conventional heat driers. The process has had limited prior application with municipal sludges and a pilot study was conducted at the Hyperion Treatment plant. Performance characteristics, process viability, and design criteria were developed based in part on results of this study.

Thermal Processing Studies

A number of field demonstrations of thermal processing were conducted for purposes of screening alternative systems and development of design criteria for the most promising systems.

- Deco Pyrolysis Demonstration

A field study of the DECO refuse pyrolytic system was conducted to develop background information on the codisposal of refuse and sludge. Based in part on this study, indirect fired reactors were deferred from further consideration.

- Vertical Shaft Furnace Tests

Carver-Greenfield dried sludge was gasified in a vertical shaft reactor. Slagging was noted and this type of reactor was deferred from further consideration.

- Gasification Tests

Gasification tests using heat dried sludge in a 3 foot diameter MHF were conducted for LA/OMA by Envirotech Corporation. Mass and energy balances, loading factors, and air emission factors were developed from the tests.

Composting Studies

Design aspects of enclosed mechanical composting were field tested during two major studies conducted at JWPCP. Process feasibility, performance characteristics, and design criteria for within vessel composting were based in part on results of this work.

Evaporation Project

Performance characteristics of sand drying beds with underdrains and lagoon drying with and without decanting were determined in pilot scale tests at JWPCP. Process performance and odor emission rates were determined and design criteria for solar drying basins were based in part on results of this study.

Landfill Demonstration

Laboratory and field tests were conducted to determine moisture relationships and the field capacity of sludge/refuse mixtures. The potential for leachate production resulting from landfill disposal of sludge cake was determined from results of this study.

Toxicant Removal Studies

A laboratory study was conducted to determine the feasibility for chemical removal of trace metals from sludge. Based on results of this study, it was determined that chemical treatment was not particularly attractive and that reliance should be placed on industrial source control programs.

SPECIAL TECHNICAL STUDIES

A number of special studies were conducted in order to investigate various aspects of sludge processing and ultimate disposal.

State-of-the-Art Survey (Ref. 5)

The State-of-the-Art review was one of the first tasks undertaken by the LA/OMA Project. The purpose of such review was to bring together available information on existing and potential sludge treatment processes as well as methods of ultimate disposal. Information developed during the study was used as a basis for more detailed investigations of alternative sludge management systems. The information was also used in screening and formulating the initial Candidate System and the development of design criteria used in later analysis.

Marketing Studies (Ref. 14)

A market investigation was conducted to determine the potential for reuse of sludge based products. First, a review of current and past sludge marketing efforts in Southern California and elsewhere in the nation was conducted to determine key factors which appeared to determine the ultimate success or failure of sludge marketing programs. Potentially marketable sludge products were then identified and reviewed. Sludge compost and heat dried sludge were identified as the most promising products for marketing. Project features important to the markets which might be served, estimates of potential sales and revenue, and characteristics which determine the long-term success of a marketing program were then developed.

The most promising markets for sludge compost were determined to be (a) the home and garden market, (b) the specialty or bulk user market, and (c) area specific agricultural markets. In terms of markets served and volume and revenue goals to be established, there are a wide range of sludge marketing strategies which could be pursued.

At one extreme would be a strategy which practically ignores price and cost considerations in an effort to maximize sales, with the goal of marketing all the sludge product which could be produced in the LA/OMA project area. Since potential 1990 sludge compost production in the project area amounts to about 268,000 tons per year, this strategy implies that the specialty, home and garden, and one of the agricultural markets would be served and a low pricing strategy followed in all markets. This strategy would generate potential sales of 282,800 tons, or about 105% of total potential production.

At the other extreme would be a strategy aimed at serving only those markets where sales revenue is projected to exceed marketing and distribution costs. Such a strategy might well concentrate marketing of sludge product on the home and garden market and the specialty market at relatively high prices. This strategy would preclude transporting a sludge product to the agricultural markets. Pursuit of this strategy is estimated to result in the marketing of no more than 27% of the 1990 sludge production, requiring disposal or some other nonconflicting use of the remainder of the sludge.

Both the elasticity of demand in the various markets and the potential to shift demand curves appeared to indicate the most desirable strategy would be to pursue a relatively high pricing strategy in the home and garden market while adopting the lower price range in the specialty market. This overall strategy would allow the producer to encourage the heavy investment in developing and differentiating the product most likely to maximize long-term sales in the home and garden market. Also, advantage would be taken of the high elasticity of demand and potential shifts in demand caused by other needs for wood by-products to maximize long-term sales and receipts in the specialty market.

In view of the foregoing, the following marketing strategy was selected for purposes of evaluation of alternative sludge management projects.

- Assume that composted sludge would be marketed to the Home and Garden market (at \$2.40 per 50 lb. bag) and to the specialty market (at \$5.50 per cu. yd.) in the LA/OMA urban area. Agricultural markets will not be served initially but will be left to future market development. Pursuit of this strategy should result in recycling about 193,900 tons per year of sludge or about 72% of the 1990 sludge production. Additionally, this strategy would appear to result in a favorable combination of revenue production and subsidy, and costs to the operating agencies.
- Assume that no sludge will be marketed initially from projects located in Desert areas because of uncertainty regarding regulations, the probable high cost of transportation of sludge products to the urban area, and the relatively small (19% of 1990 sludge production) market demand in the Antelope Valley. Market development activities could, however, pursue the establishment of a market if the project becomes the selected sludge management plan and favorable regulations are issued.

Exportation Study (Ref. 15)

The purpose of this feasibility study was to conduct a preliminary evaluation of the technical and institutional aspects associated with Candidate System Number 16, "Sludge Exportation". The study did not address marketing aspects or disclose which foreign countries would be receptors of the sludge.

It was concluded that sludge exportation is not a viable alternative for the management of all sludge generated in the LA/OMA Region. This conclusion was based primarily on the fact that costs associated with tanker transport of sludge to the prevailing exporting nations could be expected to be exceedingly high. Further, the large volume of sludge would mandate use of crude oil cargo tankage that would

most likely necessitate time-intensive tank cleaning. It should be noted, however, that a limited opportunity involving individual Agencies may arise if one or more independent tanker operators wished to transport the sludge overseas.

Results of this study together with contractual difficulties associated with overseas use of sludge lend to deferral of sludge exportation for further consideration.

Carver-Greenfield Process Evaluation (Ref. 16)

During development of the state-of-the-art survey, the Carver-Greenfield (CG) process was identified as offering considerable potential for efficient drying of sludge solids. Further evaluation of the process was conducted which drew upon information developed from pilot scale testing, field trips to existing and former installations, combustion tests on the dried product and engineering analysis of the process. It was concluded that the Carver-Greenfield system is a viable sludge drying process and offers considerable energy efficiency compared to conventional direct or indirect contact dryers. Technology involved in the Carver-Greenfield process is not beyond that which can reasonably be expected to be operated in moderate to large treatment plants. Thermal processing of mechanically dewatered, CG dried product, can produce sufficient steam and electrical power to make the CG-thermal processing system energy self-sufficient, and can even produce surplus energy. Results of this study were instrumental in development of process flow trains involving CG-thermal processing and in development of design criteria for economic and energy analysis.

Non-Sewerable Waste Study (Ref. 17)

The potential exists for significant increases in the amount of liquids received at solid waste landfill sites in the metropolitan area. This potential increase would arise from a number of factors: (1) the possible landfilling of dewatered sludge cake; (2) an increase in the quantity of liquid wastes generated by industry as a result of industrial source control ordinances; and (3) near term prospects for closure of certain landfills which currently provide for liquid waste disposal. Considerable concern exists for potential regulatory and operational problems in the management of liquid wastes including sewage sludges. A study was undertaken to determine the magnitude of the problem and the potential impact posed by landfilling of dewatered cake. The study addressed the following aspects of the problem: (1) the present and projected rates of generation and distribution of non-sewered liquid industrial wastes; (2) present and projected receiving capacities and the geographical distribution of disposal sites for non-sewered wastes; and (3) processing and regulatory alternatives in a management system for non-sewered wastes.

The known present rate of generation of non-sewered liquid industrial wastes in the LA/OMA region is 166 million gallons per year. Rates were estimated on the basis of a survey representative of industrial companies in Standard Industrial Classifications (S.I.C.) which account for the preponderance of liquid wastes hauled to landfills. The median projection is 219 MGY for the year 2000. Nearly sixty percent of the increase is expected to originate in Orange County, which now accounts for only a little more than three percent of the total.

The following key conclusions were drawn from the study results.

- Different means of disposal must be found for about 10 MGY of Group 1 wastes and 90 MGY of Group 2 liquid wastes now being handled by Ascon, Operating Industries, and Palos Verdes Landfills, if they close as expected by 1983.
- Capacity exists in the remaining disposal sites for the displaced wastes provided that solid wastes can be adequately redistributed or that disposal site owners are willing to accept higher than present liquid/solid ratios. Redistribution of both liquid and solid wastes will occur because of the impact of increased transportation and disposal costs on normal market forces.
- More capacity for Class I wastes would be available if Group 2 wastes were excluded from Class I landfills.
- Adverse consequences which could arise from poor management of non-sewered liquid wastes include: violations of State or Federal regulations; sewage treatment plant disfunctions; reductions in the reuse value of treatment plant effluents and/or sludge; and underutilization of liquid capacity at some landfills.

Based on these results, a decision was made to consider disposal of dewatered cake at Class II landfill sites in order to conserve remaining Class I capacity for truly hazardous wastes. The ability to manage liquid industrial wastes became a key consideration in development of the proposed sludge management and will be discussed further in Chapter V.

Baseline Ocean Studies (Ref. 18 to 20)

Impacts resulting from the Baseline Alternative were defined largely through review of available data and information on the state of the marine waters and conditions that have resulted from present and past discharge practices. This information was supplemented by review of other data and studies regarding the range of effects that might be expected. These studies formed the basis for marine sections included in the Draft EIS/EIR document.

Deep Ocean Disposal Study (Ref. 21)

A technical assessment of ocean disposal of sludge by deep ocean outfalls and barge dispersal was conducted by Cal Tech under contract to the LA/OMA Project. This study was funded solely by the operating agencies. Results indicate that discharge by ocean outfall should be limited to depths less than 1000 feet to reduce impacts on oxygen resources in the water column below that depth. This limitation was used in development of the project description for ocean disposal by deep ocean outfall.

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11 - 410 (a)

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CHAPTER

III

CHAPTER I

**BACKGROUND AND
PROBLEM DESCRIPTION**

CHAPTER II

**DEVELOPMENT OF THE
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MANAGEMENT PROJECTS**

CHAPTER III

**DESCRIPTION OF THE
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CHAPTER IV

**COMPARATIVE EVALUATION
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**DESCRIPTION OF THE
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CHAPTER VI

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ANALYSIS OF KEY TOPICS

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**DESCRIPTION OF THE
ALTERNATIVE SLUDGE
MANAGEMENT PROJECTS**

- **DESCRIPTIONS**
- **QUANTITATIVE INFORMATION**
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DESCRIPTION OF THE ALTERNATIVE SLUDGE MANAGEMENT PROJECTS

Development of the Proposed Sludge Management Program was initiated with the analysis of the candidate systems that could be used to process, reuse and dispose of sludge. Such analysis led to the development of fundamental sludge management alternatives which encompassed the basic concepts that are available for sludge management. Twelve alternative sludge management projects were defined through analysis of various combinations of unit processes within each fundamental management alternative and systematic identification of suitable project locations. Alternative sludge management projects were described in terms of:

- Onsite processing that would be carried out at the wastewater treatment plants including, as appropriate, transport of liquid sludge from each treatment plant to a central collection point,
- Interim transportation of sludge from one location to another for further processing prior to reuse or disposal,
- Offsite processing that would be carried out at locations removed from the wastewater treatment plants,
- Final transportation of processed sludge from processing facilities to the point of ultimate disposition, and
- Ultimate disposition of processed sludge by reuse or disposal and/or disposal of remaining residual wastes.
- Specific unit process trains were defined for each project together with geographic locations of facilities.

Table III-1 lists the twelve alternative projects and relates each project to a fundamental management alternative. The table shows which projects are "regional" and require the consolidation of all sludge to a single location for processing, and which projects are "individual" and can be carried out by the operating agencies acting individually.

TABLE III-1

ALTERNATIVE SLUDGE MANAGEMENT PROJECTS

PROJECT NUMBER	MANAGEMENT CONCEPT	PROJECT NAME
	PROJECT TYPE	
1-R-1	Long Distance Transport Regional	Solar Drying Basins
1-R-2	Long Distance Transport Regional	DESERT Energy Project
2-R-1	Dewatering and Composting Regional	Centralized Dewatering and Composting
2-S-1	Dewatering and Composting Individual	Decentralized Dewatering and Composting
2-S-1x	Dewatering and Composting Individual-OCSD	Round Canyon Composting/ Air Drying-OCSD
3-R-1	Thermal Processing Regional	Energy Recovery from Sludge and Dairy Waste
3-S-1	Thermal Processing Individual	Energy Recovery from Sludge
3-S-2	Thermal Processing Individual	Energy Recovery from Sludge and Solid Waste
4-S-1	Disposal Individual	Deep Ocean Outfalls
4-R-1	Disposal Regional	Barge Disposal
D-S-1	Disposal Individual	Truck Dewatered Cake to Landfills
6-S-1	Baseline Individual	Baseline "No Project" Alternative

DESCRIPTION OF ALTERNATIVES

Alternatives were defined which included actions by the individual agencies using separate facilities as well as consolidation of all sludge together as well as consolidation of all sludge together in regional processing and disposal facilities. Each of the alternatives is described in the following sections. Quantitative information is provided later in this chapter.

INDIVIDUAL PROJECTS

These projects, identified by the "S" in the project number could be carried out by the wastewater agencies acting independently. Except as noted in descriptions, sludge processing would be accomplished at the existing wastewater treatment plants. All projects include anaerobic digestion, which reduces the amount of sludge to be processed and which produces digester gas (about 40 percent carbon dioxide and 60 percent methane). Except for the Baseline No-Project Alternative, a combined cycle power generation system was assumed to be used to generate electricity using digester gas as a fuel. Energy derived from sludge would, as first priority, be used within the treatment plants for processing sludge and wastewater. Any energy in excess of treatment plant requirements would be marketed to the electrical utility grid. All projects except ocean disposal projects provided for polymer conditioning and mechanical dewatering of digested sludges prior to further processing. Figure III-1 shows unit process diagrams for the individual projects described in the following sections. Existing landfills were assumed for purposes of disposal of residuals -- Lopez Canyon (City of Los Angeles), Puente Hills (Los Angeles County Sanitation Districts) and Prima Deschecha (Orange County Sanitation Districts).

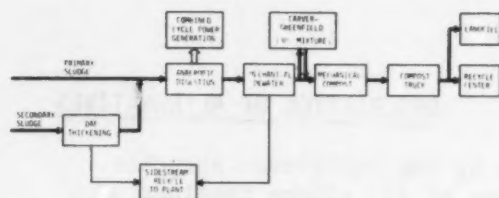
DECENTRALIZED DEWATERING AND COMPOSTING (2S1)

Dewatered sludge would be composted in an enclosed structure designed to minimize dust and odor potential and resist adverse wet weather conditions. Dehydration of a portion of the dewatered sludge would be included to provide constant moisture content in sludge fed to the composter, however, if engineering and environmental evaluations so indicate, dehydration may be deleted from the project. Composted sludge would be marketed through recycle centers at the individual treatment plants. Surplus compost containing about 30 percent moisture would be trucked to Lopez Canyon, Puente Hills, and Prima Deschecha sanitary landfills.

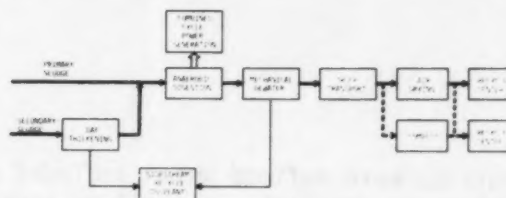
Lack of space at Hyperion would require the composting and recycle operation to be located just north of Imperial Highway at the western end of Los Angeles International Airport. Dewatered sludge at 30 percent solids would be conveyed from the treatment plant to this location by means of an underground conveyor belt system.

ROUND CANYON COMPOSTING/AIR DRYING (2S1X)

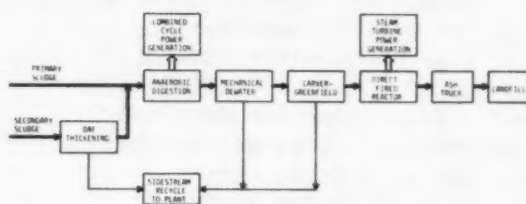
This project would provide for processing and disposal of sludges produced by Orange County Sanitation Districts and other sanitation agencies in Orange



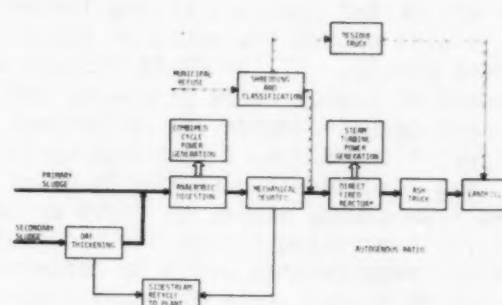
Project 2S1
Dewatering and Composting By Each Agency



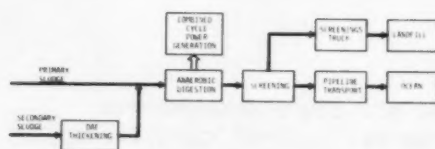
Project 2S1X
Round Canyon Composting/Air Drying



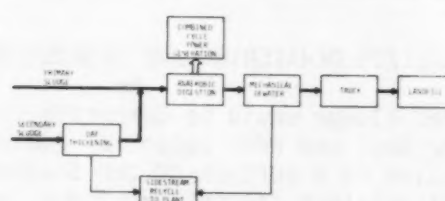
Project 3S1
Energy Recovery From Sludge



Project 3S2
Energy Recovery From Sludge and Solid Waste



Project 4S1
Deep Ocean Outfalls



Project DS1
Truck Dewatered Cake To Landfill

**UNIT PROCESS DIAGRAMS FOR
INDIVIDUAL PROJECTS**

REGIONAL SLUDGE MANAGEMENT PROGRAM
LOS ANGELES/ORANGE COUNTY METROPOLITAN AREA

FIG. III-1

County. The other LA/OMA operating agencies would not be involved in this project.

Dewatered sludge would be trucked from the wastewater treatment plants to Round Canyon in eastern Orange County. Two options exist (but combination of both are possible) for processing at Round Canyon:

- Option A would air dry dewatered sludge prior to disposal in the proposed Bee Canyon landfill. Under full secondary treatment and assuming centrifuge dewatering during winter months, it is projected that about 300 acres of land would be needed for sludge drying. About 45 acres would be needed in the summer time to produce 50 percent solids for disposal in the landfill. If 35 percent solids can be disposed of in the landfill, land requirements would be reduced to 270 acres and 30 acres respectively.
- Option B would provide for windrow composting of sludge on about 40 acres. Provided adequate source control of metals is achieved, recycling of the composted material through a recycle center located onsite might be included. Unrecycled compost would be trucked to the Bee Canyon Landfill.

The project would be used by OCSD until such time as other alternatives for long term sludge management become evident and available. After that time the proposed project would serve as a backup for OCSD to be used during periods when other facilities malfunction. Thus, it is expected that OCSD use of the project would phase out leaving other Orange County Sanitation Agencies as principal users of project facilities.

Consideration may need to be given to use of leachate control facilities at the proposed Bee Canyon landfill or air drying to 50 percent solids to mitigate landfill impacts. Additionally, a covered compost facility and land-filling of dewatered sludge could be considered as wet weather mitigation actions. The Orange County General Services Agency has prepared an EIR for the proposed Bee Canyon sanitary landfill. If efforts to site such landfill are not successful dried sludge or compost would be trucked to Prima Deschacha landfill for disposal.

Project facilities would include provision for control of onsite runoff and prevention of runoff into San Diego Creek. It could be possible to dispose of onsite runoff in an existing treatment system.

ENERGY RECOVERY FROM SLUDGE (3S1)

Dewatered sludge would be dried to about 95 percent solids in a dehydration unit and combusted in a thermal reactor for energy recovery and volume reduction. Heat from combustion of the gases produced by the thermal reactor would be used to produce steam for use in the dehydration unit and for production of electricity. Control systems using best available control technology and appropriate operation procedures would be employed to minimize air emissions. Residues (ash and char from thermal processing) would contain no water and be trucked to sanitary landfills.

ENERGY RECOVERY FROM SLUDGE AND SOLID WASTE (3S2)

Municipal solid waste bound for landfill disposal would be diverted and trucked to the treatment plants. At each of the plants, solid waste would be processed in enclosed structures to recover ferrous metals and produce supplemental fuel for sludge processing. Processed solid waste would be combined with dewatered sludge and combusted in a thermal reactor for energy recovery and volume reduction. The solid waste provides the supplemental fuel needed to enable combustion of the dewatered sludge (about 80 percent moisture) in the thermal reactor to be self sustaining and avoid use of fossil fuels. Heat from combustion of gases produced by the thermal reactor would be used to produce steam for production of electricity. Control systems using best available control technology and appropriate operation procedures would be employed to minimize air emission. Residues (ash and char from thermal processing and inert fraction of the municipal refuse) would be trucked to sanitary landfills.

DEEP OCEAN OUTFALLS (4S1)

Digested sludge would be screened and discharged to the Southern California Bight through individual sludge-only outfalls. Outfalls would extend offshore about 2.5 miles (Los Angeles County Sanitation Districts), 6.2 miles (Orange County Sanitation Districts) and 11.5 miles (City of Los Angeles) respectively and terminate at depths of about 1,000 feet. Sludge discharges would occur in deep waters on slopes leading to the Santa Monica - San Pedro Basin. Screenings would be trucked to sanitary landfills. It should be noted that discharge of sludge to the ocean is precluded by State and Federal regulations.

TRUCK DEWATERED SLUDGE TO LANDFILLS (DS1)

Dewatered sludge (about 20-25 percent solids) would be trucked to sanitary landfills for disposal. At the landfills, dewatered sludge would be mixed with incoming solid waste and buried. Leachate control systems may be required to overcome concerns with leachate production and groundwater quality protection.

REGIONAL PROJECTS

These projects, identified by an "R" in the project number, would bring digested sludge from each of the treatment plants together to a single point for processing and disposal. Projects involving land disposal would use twin high grade steel pipelines to convey digested sludge to a central collection facility and from the central collection facility to an offsite processing location outside of the LA/OMA Urban Area. One pipeline would be used for sludge pumping while the other pipeline would be used for emergency pumping, pumping during cleaning of the main pipeline, and return of liquid sidestreams to the treatment plants for disposal. Pump station sites and pipelines would be located in public rights-of-way. For all projects except barge disposal, the central collection facility is assumed to be located in the vicinity of Alondra Boulevard and 605 Freeway

(probably at the Los Coyotes Treatment Plant operated by County Sanitation Districts of Los Angeles County). Gas produced by anaerobic digestion at the individual treatment plants would be used in combined cycle power generation systems to produce electricity. Priority for use of the electricity would be for sludge processing and wastewater treatment. Any excess electrical energy would be marketed to the utility grid system. Figure III-2 provides unit process diagrams for the regional projects described in the following sections.

SOLAR DRYING BASINS (1R1)

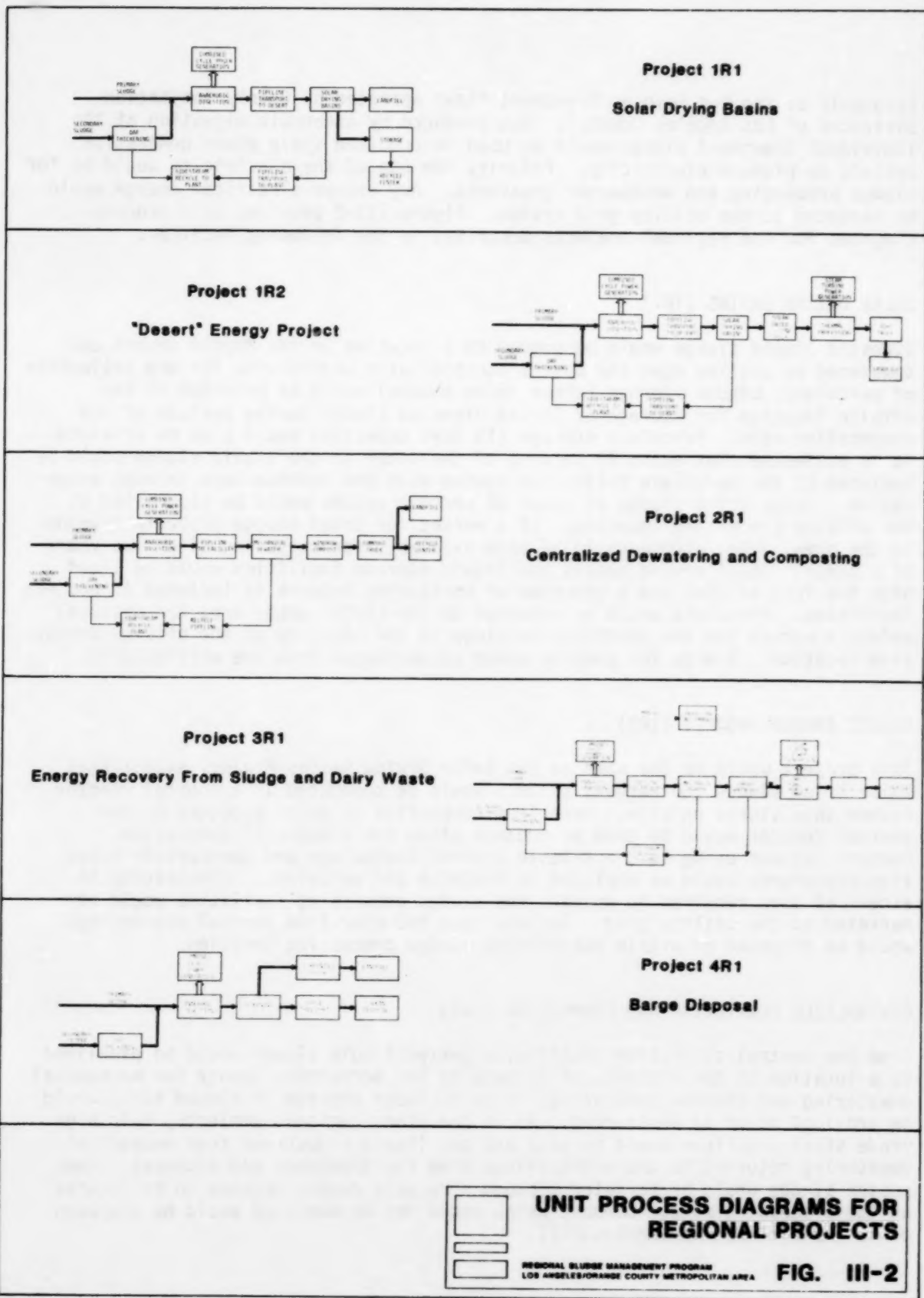
Digested liquid sludge would be pumped to a location in the Mojave Desert and dewatered by shallow open air basins equipped with underdrains for the collection of percolate. Lagoon storage (about three months) would be provided at the offsite location for storage of liquid digested sludge during periods of low evaporation rate. Percolate storage (15 days capacity) would also be provided. It is estimated that about 70 percent of the water in the liquid sludge would be captured by the percolate collection system with the balance lost through evaporation. Solar dried sludge at about 60 percent solids would be stockpiled at the offsite processing location. If a market for dried sludge products develops in the area, dried sludge could be made available for recycling after two years of storage. Solar drying basins and liquid storage facilities would be lined with two feet of clay and a groundwater monitoring network is included in project facilities. Percolate would be returned to the LA/OMA urban area for disposal unless a market for the percolate develops in the vicinity of the offsite processing location. Energy for pumping would be purchased from the utility grid.

DESERT ENERGY PROJECT (1R2)

This project would be the same as the Solar Drying Basins Project except that solar dried sludge (60 percent solids) would be combusted in a thermal reactor rather than stored on site. Heat from combustion of gases produced by the thermal reactor would be used to produce steam for electrical generation. Control systems using best available control technology and appropriate operation procedures would be employed to minimize air emissions. Electricity in excess of that required to operate the sludge processing facilities would be marketed to the utility grid. Residue (ash and char from thermal processing) would be disposed of within the offsite sludge processing location.

CENTRALIZED DEWATERING AND COMPOSTING (2R1)

From the central collection facility, digested liquid sludge would be pipelined to a location in the vicinity of Fontana in San Bernardino County for mechanical dewatering and windrow composting. Liquid sludge storage in closed tanks would be provided prior to dewatering. As in the other regional projects, twin high grade steel pipelines would be used and the liquid sidestream from mechanical dewatering returned to the metropolitan area for treatment and disposal. Composted sludge would be marketed through a recycle center assumed to be located at the processing site. Compost which could not be marketed would be disposed of in the Milliken Avenue landfill.



ENERGY RECOVERY FROM SLUDGE AND DAIRY WASTE (3R1)

From the central collection facility, digested sludge would be pipelined via twin high grade steel pipes to a location in the vicinity of Fontana, San Bernardino County, for mechanical dewatering, dehydration, and combination with animal manure and combustion in a thermal reactor for volume reduction and energy recovery. Dehydration is required since there appears to be insufficient amounts of manure to enable self-sustaining combustion of the dewatered sludge in the thermal reactor. Control systems using best available control technology and appropriate operation procedures would be employed to minimize air emissions. As in other regional projects, liquid sidestreams would be returned to the metropolitan area treatment plants for disposal. Project facilities would include manure processing and storage and tanks for storage of liquid sludge prior to dewatering.

Heat from combustion of gases produced by the thermal reactor would be used to produce steam for use in the dehydration unit and for production of electricity. Electricity in excess of that required by sludge processing equipment would be marketed to the electrical utility grid or to industries in the area. Electricity for sludge pumping would be purchased from the electrical grid. Residue (ash and char from thermal processing and inert material from manure processing) would be trucked to Milliken Avenue landfill.

BARGE DISPOSAL (4R1)

Liquid digested sludge would be screened and pipelined from each wastewater treatment plant to a dock in the Long Beach/Los Angeles Harbor for barge disposal at sea. Sludge would be loaded in barges and dispersed over large areas about 60 miles offshore by means of a flexible pipe extended to depths of about 150 feet beneath the barge. It is estimated that at least two barges of 30,000 dwt each would be needed. It should be noted that ocean dumping of sludge is currently prohibited by Federal law and regulations.

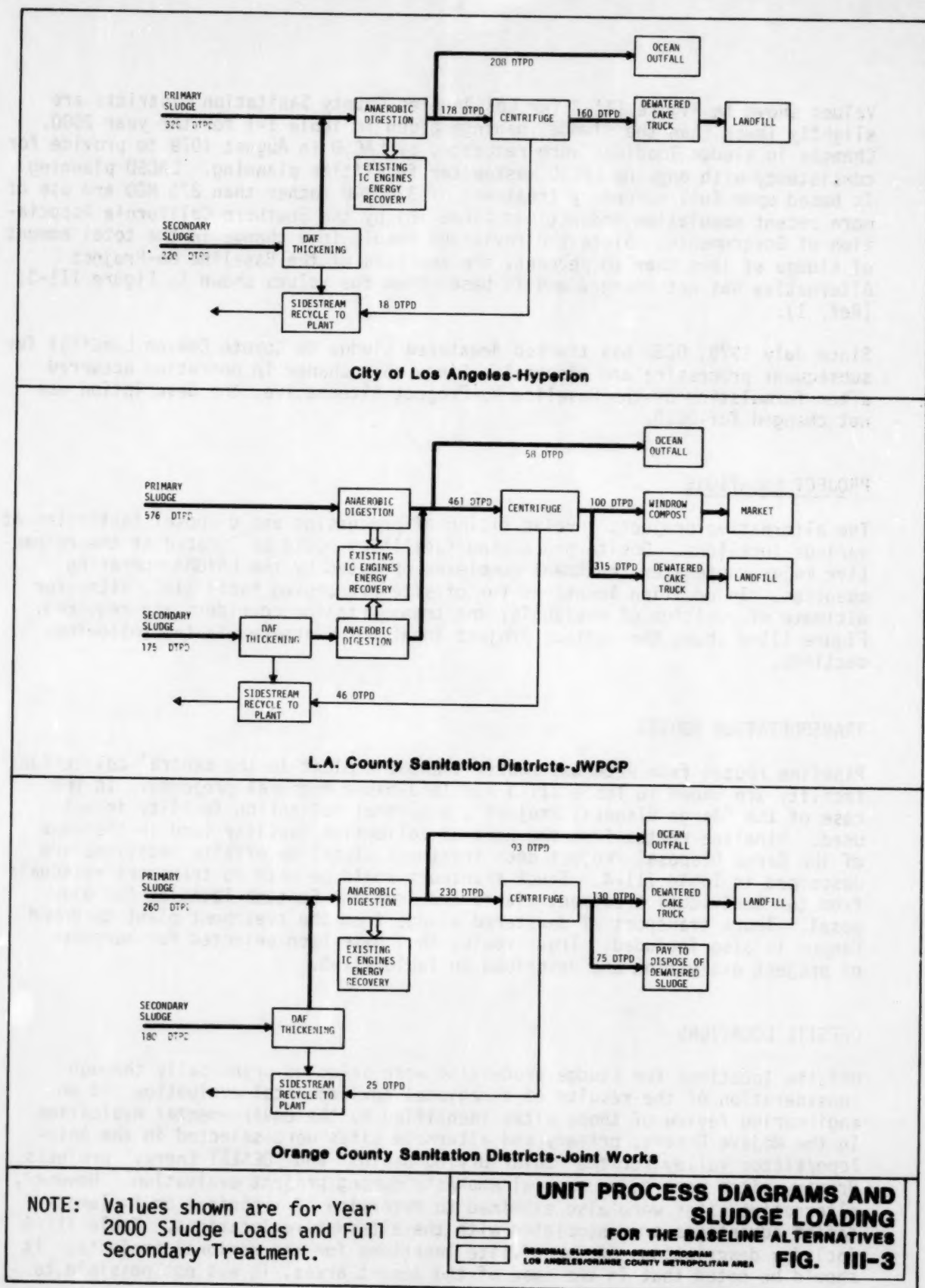
BASELINE NO-PROJECT ALTERNATIVE (6S1)

This project provides a basis for comparison of alternative sludge management projects and corresponds to the No-Project Alternative required to be analyzed by the National Environmental Policy Act and the California Environmental Quality Act. Anaerobically digested sludge in excess of dewatering capacity installed or committed for installation as of December 31, 1978, would be discharged to the ocean through existing outfall systems described in Table III-2. Dewatered sludge (at about 18 percent solids) in excess of downstream composting capacity would be trucked to sanitary landfills for disposal. Gas produced from anaerobic digestion would continue to be used in existing internal combustion engines to produce electricity and for driving pump motors. Digester gas in excess of the capacity of the existing engines is assumed to be used in commercial or utility boilers at locations near the wastewater treatment plants. Figure III-3 shows the unit process diagrams and distribution of sludge under the Baseline Alternative for each LA/OMA operating agency according to baseline processing capacities established as of December 31, 1978.

TABLE III-2

EXISTING OCEAN OUTFALL SYSTEMS
LA/OMA MUNICIPAL DISCHARGES

	YEAR CONSTRUCTED	LENGTH	DIAMETER	DEPTH	DIFFUSER	PORTS
<u>CITY OF LOS ANGELES</u>						
Hyperion Five Mile (Effluent Line)	1960	8,400 m (27,600 ft)	3.7 m (12.0 ft)	57 m (188 ft)	wye, each leg 1,220 m (4,000 ft)	168
Seven Mile (Sludge Line)	1957	11,200 m (36,700 ft)	.56 m (1.8 ft)	98 m (320 ft)	none	none
<u>LOS ANGELES COUNTY SANITATION DISTRICTS</u>						
Joint Water Pollution Control Plant Outfall No. 3	1956	2,400 m (8,000 ft)	2.3 m (7.5 ft)	60 m (200 ft)	wye, each leg 366 m 1,200 ft	100
Outfall No. 4	1965	3,600 m (12,000 ft)	3.0 m (10.0 ft)	60 m (200 ft)	1,340 m (4,400 ft)	740
<u>ORANGE COUNTY SANITATION DISTRICTS</u>						
Joint Works	1971	6,500 m (21,400 ft)	3.0 m (10.0 ft)	60 m (200 ft)	1,840 m (6,000 ft)	500



Values shown in Figure III-3 for Los Angeles County Sanitation Districts are slightly lower than the sludge loadings given in Table I-1 for the year 2000. Changes in sludge loadings were requested by LACSD in August 1979 to provide for consistency with ongoing LACSD wastewater facilities planning. LACSD planning is based upon full secondary treatment of 330 MGD rather than 275 MGD and use of more recent population projections (SCAG 78) by the Southern California Association of Governments. Since the revisions result in a change in the total amount of sludge of less than 10 percent, the analysis of the Baseline No-Project Alternative was not changed and is based upon the values shown in Figure III-3. (Ref. 1).

Since July 1979, OCSD has trucked dewatered sludge to Coyote Canyon Landfill for subsequent processing and disposal. Since this change in operation occurred after formulation of the Baseline No-Project Alternative, the description was not changed for OCSD.

PROJECT LOCATIONS

The alternative projects involve siting of processing and disposal facilities at various locations. Onsite processing facilities would be located at the respective major wastewater treatment complexes operated by the LA/OMA operating agencies. In addition locations for offsite processing facilities, sites for ultimate disposition of residuals, and transportation corridors are required. Figure III-4 shows the various project locations discussed in the following sections.

TRANSPORTATION ROUTES

Pipeline routes from each wastewater treatment plant to the central collection facility are shown in Table III-3 for land-based regional projects. In the case of the "Barge Disposal Project", a central collection facility is not used. Pipeline routes from the central collection facility (and in the case of the Barge Disposal Project each treatment plant) to offsite locations are described in Table III-4. Truck transport would be used to transport residuals from the individual treatment plants and from the Fontana location for disposal. Truck transport of dewatered sludge from the treatment plant to Round Canyon is also included. Truck routes that have been selected for purposes of project evaluation are described in Table III-5.

OFFSITE LOCATIONS

Offsite locations for sludge processing were selected principally through consideration of the results of a regional environmental evaluation and an engineering review of those sites identified by the environmental evaluation. In the Mojave Desert, primary and alternate sites were selected in the Antelope/Victor Valley for the "Solar Drying Basins" and "DESERT Energy" projects. Primary sites were given special emphasis during project evaluation. However, alternative sites were also examined to determine if technical or implementation advantages are associated with the alternative locations. Table III-4 includes descriptions of the offsite locations for the regional projects. It should be noted that in the case of the desert areas, it was not possible to

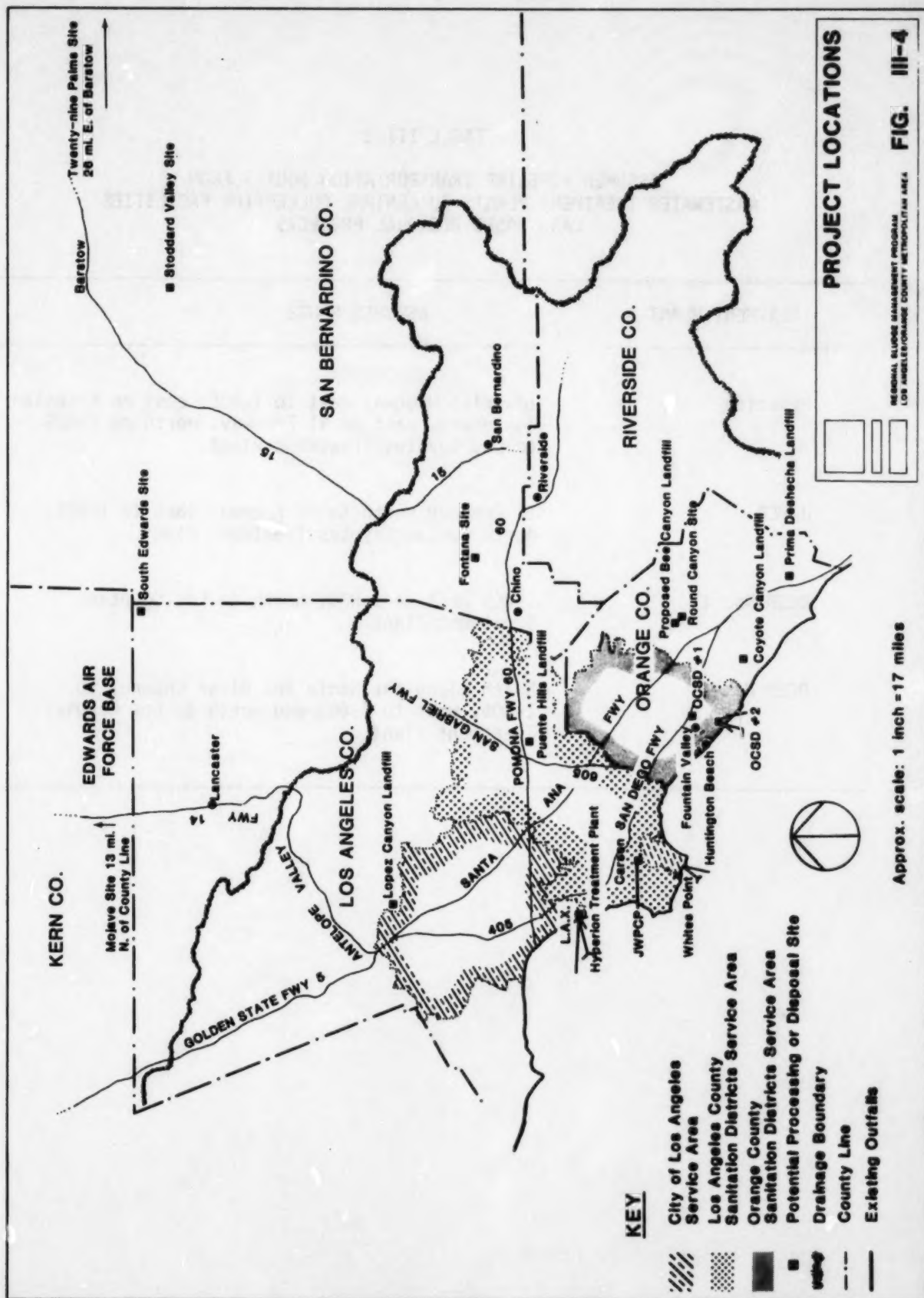


TABLE III-3

ASSUMED PIPELINE TRANSPORTATION ROUTES FROM
WASTEWATER TREATMENT PLANTS TO CENTRAL COLLECTION FACILITIES
LAND BASED REGIONAL PROJECTS

TREATMENT PLANT	ASSUMED ROUTE
Hyperion	Imperial Highway east to I-405, east on Artesia Boulevard, east on 91 Freeway, north on I-605 to Los Coyotes Treatment Plant.
JWPCP	11 Freeway north to 91 Freeway east to I-605, north to Los Coyotes Treatment Plant.
OCSD No. 1	I-405 west to I-605, north to Los Coyotes Treatment Plant.
OCSD No. 2	North along the Santa Ana River Channel to I-405, west to I-605 and north to Los Coyotes Treatment Plant.

TABLE III-4
OFFSITE LOCATIONS AND ASSUMED PIPELINE CORRIDORS FOR REGIONAL PROJECTS

PROJECT NUMBER	NAME	OFFSITE LOCATION	PIPELINE CORRIDOR FROM CENTRAL COLLECTION	
			POINT TO OFFSITE LOCATION	
1R1 1R2	Solar Drying Basins DESERT Energy Project	South Edwards (Primary) ⁽¹⁾ Gross Area: 38,000 acres	North on 605 Freeway to I-5; north on I-5 to Antelope Valley Freeway (Hwy 14); Antelope Valley Freeway to Hwy 138; East on Hwy 138 to Palmdale Blvd., continuing east on Palmdale Blvd. to 90th St. East; North on 90th St. East to Avenue I; east on Avenue I to 130th St. East; north on 130th St. East to Avenue G; east on Avenue G to 200th St. East; Follow terrain to central portion of location.	
		Mojave City (Alternate) Gross Area: 21,000 acres	Same as South Edwards except continue north on Antelope Valley Freeway to the location.	
		Stoddard Valley (Alternate) Gross Area: 10,000 acres	North on 605 Freeway to I-10; east on I-1 to I-15; north on I-15 through Victorville to Stoddard Wells Road; along Stoddard Wells Road to the northern portion of the location.	
		Twenty-Nine Palms (Alternate) Gross Area: 52,000 acres	Same as Stoddard Valley except continue north on I-15 to I-40; east on I-40 to the location.	
2R1	Centralized Dewatering and Composting	Fontana Gross Area: 800 acres	North on 605 Freeway to I-10; east on I-10 to the location.	
3R1	Energy Recovery from Sludge and Dairy Waste	Fontana Gross Area: 800 acres	Same as 2R1	
4R1	Barge Disposal	Long Beach/Los Angeles Harbor Gross Area: Not applicable	From Hyperion Treatment Plant, south on Vista Del Mar to Rosecrans Ave., east on Rosecrans to I-405, south on I-405 to Harbor Freeway (Hwy 11), south on Harbor Freeway to JMWCP, continuing south on Harbor Freeway to the harbor area. From CSDOC, generally north on Pacific Coast Hwy to the harbor area.	

(1) Primary site was used for purposes of project evaluations. Alternate sites were examined in comparison with the primary site to determine if advantages or disadvantages were associated with the alternate sites.

TABLE III-5

ASSUMED TRUCK TRANSPORTATION ROUTES
FOR ALTERNATIVE SLUDGE MANAGEMENT PROJECTS

ORIGIN	DESTINATION	ASSUMED ROUTE
Hyperion	Lopez Canyon Landfill	Imperial Hwy. east to northbound I-405 to eastbound I-118, exit onto Paxton St. at Glenoaks Blvd., north to Lopez Canyon Road and north to entrance road.
JWPCP	Puente Hills Landfill	Pacific Coast Hwy. entrance to 11 Freeway north, 91 Freeway east I-605 Freeway north, Peck Road exit, Pellissier Road to Workman Mill, Workman Mill to entrance road.
OCSD No. 1	Prima Deschecha Landfill	Ellis Street to I-405 Freeway, east to I-5 Freeway, south to San Juan Creek Road exit, and San Juan Creek Road to rural roads to entrance road.
OCSD No. 2	Prima Deschecha Landfill	Brookhurst Street north to I-405 Freeway east to I-5 south to San Juan Creek Road exit, and San Juan Creek Road to rural roads to entrance road.
Fontana Location	Milliken Landfill	G Street west to Milliken Ave. and south to landfill.
OCSD No. 1 OCSD No. 2	Round Canyon	Ellis Street to I-405 Freeway; Brookhurst St. north to I-405 Freeway; I-405 Freeway to Laguna Freeway to I-5 Freeway to Sand Canyon exit; Sand Canyon Road to Irvine Boulevard to site entrance.
Round Canyon	Bee Canyon	New road that would be constructed in foothills between Round Canyon and Bee Canyon.

consider the entire Mojave Desert in the evaluation. It is believed however that the sites selected for purpose of project evaluation provide an adequate basis for comparison with other alternative projects. It should be recognized that selection of a project involving the Desert would require that additional site selection studies involving the balance of the Desert be conducted.

The regional composting project and the thermal processing project involving codisposal with dairy manure are proposed to be sited in the Fontana area north of Interstate 10 and south of the Southern California Edison Etiwanda Generating Station between Interstate 15 and Kaiser Steel Mill. This site is in close proximity to the dairy industry.

Each of the regional locations contain more than the minimal amount of land needed for the respective project facilities. The total area of the location has been considered in the analysis of the projects to permit flexibility for responding to the findings of environmental and engineering studies through judicious location of project facilities within the general site boundaries.

Some individual projects also involve sludge processing at sites removed from the wastewater treatment plants. In the case of the City of Los Angeles, there is insufficient land within the Hyperion treatment plant boundaries to accommodate full scale composting facilities. Accordingly, offsite sludge composting operations are proposed to be located in vacant land at the western end of the Los Angeles International Airport. In view of potential presence of habitat of the El Segundo Blue Butterfly, an endangered species within the site, care would have to be taken in siting facilities to avoid impacts on this insect.

Currently, OCSO trucks dewatered sludge to the Coyote Canyon Landfill site for air drying and disposal in the landfill. This operation is interim and will terminate with the closure of the landfill in 1983. The regional environmental evaluation has disclosed that Round Canyon, located in the Lomas de Santiago foothills of eastern Orange County, would be a potentially suitable location for offsite processing of sludge by Orange County Sanitation Districts. The area, which encompasses about 300-400 acres in total, is located easterly of the El Toro Marine Corps Air Station.

The Barge Disposal Project would involve storage and barge loading facilities in the Los Angeles/Long Beach Harbor complex. For purposes of project evaluation, terminal facilities are proposed to be located in the outer Los Angeles Harbor on vacant lands at the end of Ferris Avenue on Terminal Island. Docking facilities to accommodate two 30,000 dwt barges would be required.

ULTIMATE DISPOSAL

LA/OMA Marketing studies indicate that urban demand for sludge compost products should be about 193,900 tons per year by the year 2000 (Ref. 2). For purposes of analysis of alternatives it has been assumed that this demand would be supplied first by composted sludge from LACSD, second by compost from OCSO, and lastly from compost from CLA. For certain projects, supplying this demand reduces the quantity of residuals which must be disposed.

Each project requires facilities for disposal of residual waste material. Residuals vary according to project and include such materials as liquid digested sludge, unrecycled compost, and ash. Table III-6 lists for each alternative project the type of residual generated, the water content of the residual, and the ultimate disposal site for the residual. Values shown for Projects 2S1 and 2R1 are based upon the marketing strategy just described.

DESIGN ASSUMPTIONS

Development of certain aspects of the alternative management projects would have required detailed design studies. Such studies were premature and, if conducted as part of the planning process, would have resulted in needless expenditure of resources for plan development. As a result, assumptions were made where specific information was needed to enable evaluation of potential environmental impacts.

INDIVIDUAL PROJECTS

Assumptions that are applicable only to the individual projects are as follows:

- A leachate control system acceptable to the Regional Water Quality Control Board was assumed to exist at the Puente Hills Landfill, since such system was under design at the time of the assessment of the alternative projects.
- Thermal processing reactors (processors) were assumed to require 2700 gallons per minute of cooling water.
- It was assumed that cooling water from the thermal processors for the energy recovery projects (Projects 3S1 and 3S2) would be discharged to the ocean with treated wastewaters.

REGIONAL PROJECTS

Assumptions applicable only to the regional projects are as follows:

- The pump station at the central collection facility was assumed to have two levels.
- Alternatives involving use of solar drying basins (Projects 1R1 and 1R2) would include protective liners for the solar drying basins, percolate storage, lagoon storage and a groundwater quality monitoring network. Solar drying, percolate storage, and lagoon storage facilities would not be enclosed.
- Final disposal/storage area for the Solar Drying Basins Project (Project 1R1) would occupy approximately 300 acres and be 100 feet tall.
- The Centralized Dewatering and Composting Project (Project 2R1) would include 10 covered liquid sludge storage tanks, each 100 feet in diameter and 40 feet high.

TABLE III-6
ULTIMATE DISPOSITION OF RESIDUALS
FROM ALTERNATIVE SLUDGE MANAGEMENT PROJECTS

(Year 2000 Sludge Loads-Full Secondary Treatment)

PROJECT NUMBER	PROJECT NAME	AGENCY	ULTIMATE DISPOSITION	TYPE	RESIDUALS		NOTES
					WET WEIGHT TON/DAY	PERCENT SOLIDS	
2S1	Individual Dewatering and Composting	CLA LACSD OCSD	Lopez Canyon Puente Hills Prima Deschecha	Compost Compost Compost	349 0 221	70 70 70	(a)
2S1X	Round Canyon Project	OCSD	Bee Canyon	Compost	284	70	(b)
3S1	Energy Recovery from Sludge	CLA LACSD OCSD	Lopez Canyon Puente Hills Prima Deschecha	Ash Ash Ash	128 187 104	100 100 100	(c) (c) (c)
3S2	Energy Recovery from Sludge & Solid Waste	CLA LACSD OCSD	Lopez Canyon Puente Hills Prima Deschecha	Ash Inerts Ash Inerts Ash Inerts	190 134 246 128 155 109	100 80 100 80 100 80	(c) (c) (c) (c)
4S1	Deep Ocean Outfalls	CLA LACSD OCSD	Ocean Ocean Ocean	Liquid Liquid Liquid	13,000 19,000 10,700	3 3 3	(d) (d) (d)
DS1	Truck Dewatered Sludge to Landfill	CLA LACSD OCSD	Lopez Canyon Puente Hills Prima Deschecha	Cake Cake Cake	1,604 1,819 1,304	23 26 23	
1R1	Solar Drying Basins	Regional	Offsite Processing	Dried Sludge	1,903	60	
1R2	Desert Energy Project	Regional	Offsite Processing	Ash	419	100	
2R1	Centralized Dewater- ing & Composting	Regional	Milliken	Compost	610	70	
3R1	Energy Recovery from Sludge & Dairy Waste	Regional	Milliken	Ash Inerts	510 56	100 80	
4R1	Barge Disposal	Regional	Ocean	Liquid	42,700	3	(d)
6S1	Baseline No-Project	CLA LACSD OCSD	Lopez Canyon Ocean Puente Hills Ocean Prima Deschecha Ocean	Cake Liquid Cake Liquid Cake Liquid	890 6,900 1,750 1,900 720 3,100	18 3 18 3 18 3	(d) (d) (d) (d)

(a) Assumes that 63 wet tons per day of compost is recycled.

(b) Assumes no compost is recycled. Dried sludge may constitute a portion of the residual.

(c) Assumes landfill site is found to be acceptable by regulatory agencies.

(d) Liquid digested sludge is the residual.

- Thermal processors would require 2700 gpm of cooling water. The Desert Energy Project (Project 1R2) would use water from the percolate evaporation ponds.
- Percolate storage would be used as a heat sink for condensers in the Desert Energy Project (Project 1R2). The percolate storage ponds would be sized as necessary to provide the necessary cooling, so that additional sources of water would not be necessary.
- Animal wastes in the Energy Recovery from Sludge and Dairy Waste Project (Project 3R1) would be combined with cooling water from the Etiwanda Power Plant for disposal. Cooling water would not receive treatment since it would not be returned to the treatment plants through the return pipe.
- The pipe carrying return flow from Fontana back to the treatment plants for the Centralized Dewatering and Composting (Project 2R1) and Energy Recovery from Sludge and Dairy Waste (Project 3R1) alternatives would be designed to accommodate all of the return flow that must be returned to the plants for treatment.

ALL PROJECTS

Assumptions applicable to all alternative projects are as follows:

- Each of the operating agencies would provide full secondary treatment of all wastewaters. Although each agency planned to file for a waiver of the secondary treatment requirements, full secondary was assumed because it was not possible to forecast the decision. Waiver applications for all three operating agencies were filed on or about September 13, 1979.
- Construction and operation practices would be similar to that currently occurring, with no unusual, special considerations given to the proposed alternatives. In addition, the age of the equipment was assumed to be mid-life, neither too new not to have experienced any breakdowns but not so old that breakdowns were common.
- Market demands would first be met with compost from LACSD, secondly with compost from OCSD, and lastly from compost from CLA. (Ref. 2). It was assumed that compost would be transported from the recycle center for a distance of about 40 miles.
- The entire site would be considered for implementation of an alternative, regardless of the actual acreage requirements involved, to provide an indication of the suitability of various places within the site for siting project facilities.
- Adequate runoff and flood control systems would be provided at all sites.
- The only new facilities that would be constructed at OCSD No. 2 would be dissolved air flotation thickeners and anaerobic digesters. All other equipment and buildings would be located at OCSD No. 1.

- For CLA, new facilities at Hyperion would be enclosed in buildings of at least the same architectural quality as existing buildings. The area around the plant would be landscaped in the same fashion as the existing plant.
- Building height for the dehydration process would be 80 feet; thermal process - 80 feet; solid waste process - 40 feet; mechanical dewatering - 40 feet; and mechanical composting sheds - 20 feet.
- Trucks used for transport of sludge would have welded beds to prevent leaks and would be covered to reduce dust, odors, and public health risks.
- Mechanical dewatering includes both belt presses and centrifuges. LA/OMA Project has assumed, for purposes of analysis of alternatives, that belt presses would be used in all projects except the Baseline No-Project Alternative. Since centrifuges were either in operation or scheduled to go into operation as of December 31, 1978, centrifuge dewatering is included in the Baseline Project. This selection of dewatering system is not a final design decision since data indicate a close comparison between systems.
- Assumptions have been made regarding design and operating features of various unit processes. These assumptions, given in Table III-7 are related primarily to control of nuisance sources. These assumptions are not final design decisions and may be changed as a result of alternative analysis and detailed design.

TABLE III-7
DESIGN AND OPERATING ASSUMPTIONS
RELATED TO NUISANCE CONTROLS

UNIT PROCESS	ASSUMED DESIGN/OPERATING FEATURES
Thickening	Not enclosed. Noise not audible at 50-100 feet from facility.
Anaerobic Digestion	Normal operating and maintenance. Noise dissipated within 50 feet from facility.
Mechanical Dewatering	Enclosed in a well ventilated building. No provision for scrubbing or filtering of vented air. Noise dissipated within treatment plant boundaries.
Combined Cycle Power Generation	Enclosed. Noise dissipated within 50 feet of facility.
Dehydration	Enclosed. No provision for pelletizing or other special handling of dry product. Noise dissipated within 50 feet of facility.
Solid Waste Processing and Storage	Processing facilities enclosed. Storage facilities not enclosed. Noise dissipated within 200 feet of facility. No night time operation. Daytime operation will process sufficient solid waste to enable continuous project operation during night time and weekends.
Thermal Processing	Enclosed. Air within building used as combustion air for furnace. Noise dissipated within 200 feet of building.
Windrow Composting	Not enclosed. Noise source (turning devices and trucks) would be dissipated within treatment plant boundaries. No operation after 10:00 p.m.
Mechanical Composting	Enclosed. Air from building exhausted through old compost. Noise would be dissipated within 200 feet of facility.
Recycle Center	Open air storage of composted sludge. Noise dissipated within 200 feet of facility.

SOURCE: Daniel, Mann, Johnson & Mendenhall

QUANTITATIVE INFORMATION

Quantitative information has been developed by LA/OMA Project for each of the alternative management projects. This information is used, together with the foregoing qualitative descriptions, in the assessment of alternatives described later. Information on economics, air pollutant emissions, and energy balances is presented and discussed in Chapter IV.

FACILITY REQUIREMENTS:

Building size and acreage requirements for individual projects are given in Table III-8. Similar data for regional projects is given in Table III-9.

LAND REQUIREMENTS:

Total acreage required for each of the alternative management together with gross acreage available for use at each of the project locations is given in Table III-10.

SLUDGE DISCHARGE TO THE OCEAN:

Historical and projected mass emission rates of certain trace metals and chlorinated hydrocarbons under the Baseline No-Project Alternative are given in Table III-11.

Substantial reductions in mass emission of suspended solids are projected for Los Angeles County Sanitation Districts and Orange County Sanitation Districts. A smaller reduction in the City of Los Angeles' five-mile (effluent) outfall is also projected while an increase is projected for the City's seven-mile (sludge) outfall. Reductions can be attributed to improved wastewater treatment (secondary treatment has been assumed for the Baseline) at all agencies. The larger reductions at Los Angeles County and Orange County Sanitation Districts are the result of removal of digested sludge solids from the effluent outfalls. Increases in the City's seven-mile outfall reflect projected increases in sludge loadings by year 2000.

Two of the alternative projects involve disposal of all screened, digested sludge in the ocean. Table III-12 shows the mass emission rates of certain trace metals and chlorinated hydrocarbons that are projected to result from these alternatives. It should be noted that the 1985 projections assume no industrial source control beyond 1978 levels, while the year 2000 projections assume EPA electroplating industrial pretreatment requirements are applied to all known industrial discharges to the sewerage systems.

TRANSPORTATION CHARACTERISTICS

Table III-13 provides data which describes truck transportation requirements for each of the alternative management projects. Information on the amount of material to be transported and the distances involved is provided. These data

TABLE III-8
FACILITY REQUIREMENTS
ALTERNATIVE INDIVIDUAL SLUDGE MANAGEMENT PROJECTS

FACILITY	NUMBER	BLDG. SIZE (SQ. FT.)	AREA (ACRES)	ALTERNATIVE PROJECTS						
				2S1	2S1-X	3S1	3S2	4S1	DS1	6S1
DAF Thickeners										
Hyperion	16			•	•	•	•	•	•	•
JWPCP	13			•	•	•	•	•	•	•
OCSD	13			•	•	•	•	•	•	•
Anaerobic Digesters(a)										
Hyperion	12			•	•	•	•	•	•	•
JWPCP	23			•	•	•	•	•	•	•
OCSD	14			•	•	•	•	•	•	•
Belt Press Dewatering										
Hyperion		45,000		•	•	•	•		•	
JWPCP		51,000		•	•	•	•		•	
OCSD		37,000		•	•	•	•		•	
Centrifuge Dewatering										
Hyperion		13,000								•
JWPCP		32,000								•
OCSD		17,000								•
Dehydration Unit										
Hyperion		12,000		•						
		21,000				•				
JWPCP		9,000		•						
		21,000				•				
OCSD		10,000		•						
		19,000				•				
Combined Cycle Power Plant										
Hyperion		3,700		•	•	•	•	•	•	
JWPCP		5,100		•	•	•	•	•	•	
OCSD		3,000		•	•	•	•	•	•	
Mechanical Composting										
Hyperion		480,000		•						
JWPCP		630,000		•						
OCSD		390,000		•						
Windrow Composting										
JWPCP			19							•
OCSD			40		•					
Thermal Processor										
Hyperion		28,000				•				
		45,000					•			
JWPCP		29,000				•				
		45,000					•			
OCSD		27,000				•				
		36,000					•			
Solid Waste Processing										
Hyperion		17,000					•			
JWPCP		16,000					•			
OCSD		14,000					•			
Recycle Center										
Hyperion			1.7	•						
JWPCP			2.2	•						
			0.5							•
OCSD			1.4	•						
Sludge Turning Machines										
JWPCP	2									•
OCSD	5				•					

(a) New additional digesters in excess of existing capacity. Assumed to be 100 ft. in diameter and 30 ft. high.

TABLE III-9
FACILITIES REQUIREMENTS
ALTERNATIVE REGIONAL SLUDGE MANAGEMENT PROJECTS

(Full Secondary Treatment - Year 2000)

FACILITY	NUMBER	BLDG. SIZE (SQ. FT.)	LAND AREA (ACRES)	ALTERNATIVE PROJECTS				
				1R1	1R2	2R1	3R1	4R1
DAF Thickeners								
Hyperion	16			•	•	•	•	•
JWPCP	13			•	•	•	•	•
OCSD	13			•	•	•	•	•
Anaerobic Digesters ^(a)								
Hyperion	12			•	•	•	•	•
JWPCP	23			•	•	•	•	•
OCSD	14			•	•	•	•	•
Combined Cycle Power Plant								
Hyperion		3,700		•	•	•	•	•
JWPCP		5,100		•	•	•	•	•
OCSD		3,000		•	•	•	•	•
Drying Basins			510	•	•			
Liquid Sludge Storage Lagoons			375	•	•			
Percolate Storage Ponds			12	•	•			
Shop Area		35,000		•	•			
Groundwater Monitoring Wells	60			•	•			
Sludge Turning/Removal Machines	15							
Sludge Storage/Disposal Area			300 ^(b)	•	•	•		
Thermal Processing		41,000 50,000			•			
Liquid Sludge Storage Tanks	10 ^(c)						•	
Belt Press Dewatering		132,000 137,000				•		
Windrow Composting			140			•	•	
Sludge Recycle Center			6			•		
Dehydration Unit	35,000							
Animal Waste Processing & Storage	21,000						•	

- (a) New in addition to existing capacity. Assumed to be 100 ft. diameter and 30 ft. high.
(b) Ultimate height of pile assumed to be 100 ft.
(c) Assumed to be 100 ft. diameter and 40 ft. high.

TABLE III-10
LAND AREA REQUIREMENTS
ALTERNATIVE SLUDGE MANAGEMENT PROJECTS (a)

Full Secondary Treatment - Year 2000
(acres)

	Hyperion	JWPCP	OCSD (b)	LAX	Round Canyon	Fontana	South Edwards	Mojave City	Stoddard Valley	Twenty-Nine Palms
Total Available Area	20	85	33	250	640	1,200	39,000	7,600	23,000	16,000
Project No.										
2S1	7	48	31	29						
2S1-X			49							
3S1	9	13	9							
3S2	14	17	13.7							
4S1	5	8	5							
DS1	7	10	7							
1R1	5	8	5				3,300 (c) 1,200 (d)	3,300 (c) 1,200 (d)	3,300 (c) 1,200 (d)	3,300 (c) 1,200 (d)
1R2	5	8	5				3,300 (c) 900 (d)	3,300 (c) 900 (d)	3,300 (c) 900 (d)	3,300 (c) 900 (d)
2R1	5	9	6			180				
3R1	5	9	6			60				
4R1	5	8	5							
6S1	6	30	6							

- (a) Does not include lands encompassed by existing sanitary landfills.
(b) Acreage combined for OCSD Plants No. 1 and No. 2.
(c) Total area including buffer.
(d) Required for construction of facilities.

TABLE III-11

**MASS EMISSION RATES UNDER THE BASELINE ALTERNATIVE
LA/OMA MUNICIPAL DISCHARGES**

(Metric Tons Per Year)

Constituent	Los Angeles County San. Dist.				City of Los Angeles				Orange County San. Dist.							
	Combined Outfall				Five-Mile Outfall				Seven-Mile Outfall				Combined Outfall			
	1976	1977	1985	2000	1976	1977	1985	2000	1976	1977	1985	2000	1976	1977	1985	2000
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
Suspended Solids	138,900	102,000	19,900	30,790	38,300	27,300	15,100	16,600	56,200	51,500	58,000	68,900	32,000	33,300	8,940	42,500
Trace Metals																
Silver	6.3	3.7	1.9	2.2	5	13.3	3.3	3.6	4.9	12.0	7.0	11	2.5	2.5	0.7	3.0
Arsenic	3.4	4.2	---	1.8	5	4.4	2.5	1.5	1.6	1.3	1.3	2.3	---	---	---	---
Cadmium	12.8	11.6	2.3	0.8	10	8.8	2.0	0.7	7.4	8.3	8.0	2	10	10.9	1.6	2.6
Chromium	370	176	50	6.0	95	57.3	23	2.5	66	81.4	96	12	48	42	8.5	12
Copper	200	116	32	7.9	85	88	24	8.3	95	98.6	93	61	91	81.5	19	37
Mercury	0.7	0.5	0.2	0.1	0.8	0.9	0.3	0.2	0.6	0.8	0.7	0.8	---	---	---	---
Nickel	157	111	100	9.3	90	79.4	61	27	21	26.1	18	13	35	32.1	30	35
Lead	108	87.8	40	4.6	15	13.2	6.1	3.5	9.4	13.7	11	14	28	23.4	14	15
Zinc	650	388	160	45	109	141	50	42	120	178	100	116	140	101	43	72
Chlorinated																
Total DDT	0.9	0.7	0.2	0.20	0.03	0.01	0.02	0.02	0.02	0.01	0.09	0.1	0.03	0.01	0.01	0.01
Total PCB	1.3	0.3	0.2	0.25	0.01	0.01	0.07	0.08	0.01	0.01	0.35	0.4	1	1	0.05	0.43

NOTE: 1976 and 1977 data from Coastal Water Research Project (SCMRP) Annual Reports 1977 and 1978.
1985 and 2000 data are projections by LA/OMA Project.

(a) Projections assume No Source Control beyond 1978 level and full secondary treatment.

(b) Projections assume source control and industrial pretreatment assuming proposed EPA Pretreatment requirements for electroplating industries (43 FR 6560, February 14, 1978) are applied to all known industrial sources. Full secondary treatment is assumed.

TABLE III-12

MASS EMISSION RATES FOR TOTAL SLUDGE DISCHARGE IN THE OCEAN
LOS ANGELES/ORANGE COUNTY METROPOLITAN AREA

Full Secondary Treatment

(Metric Tons/Year)

CONSTITUENT	LOS ANGELES COUNTY SANITATION DISTRICTS		CITY OF LOS ANGELES (a)		ORANGE COUNTY SANITATION DISTRICTS	
	1985(b)	2000(c)	1985(b)	2000(c)	1985(b)	2000(c)
Suspended Solids	152,300	152,300	110,900	122,180	76,160	99,670
Trace Metals						
Silver	6.5	7.0	13	20	2.6	6.0
Arsenic	---	3.8	2.4	4.1	---	---
Cadmium	12	2.8	15	3.6	12	5.1
Chromium	283	25	184	21	69	28
Copper	168	44	177	108	143	30
Mercury	0.6	0.6	1.2	1.7	---	---
Nickel	57	6.8	34	22	17	23
Lead	119	18	22	25	50	33
Zinc	513	165	199	206	173	140
Chlorinated Hydrocarbons						
Total DDT	0.9	0.9	0.2	0.2	0.04	0.04
Total PCB	1.1	1.1	0.7	0.7	0.5	0.5

(a) Seven Mile Outfall

(b) Projections assume no source control beyond 1978 level.

(c) Projections assume source control and industrial pretreatment assuming proposed EPA Pretreatment requirements for electroplating industries (43 FR 6560; February 14, 1978) are applied to all known industrial sources.

TABLE III-13

**AMOUNTS OF MATERIAL TO BE TRANSPORTED
ALTERNATIVE SLUDGE MANAGEMENT PROJECTS**

**Full Secondary Treatment - Year 2000
(cubic yards per day)**

Project Number: Material (See Below):													
Route		Distance (miles)											
2S1 C	2S1-X C/D	3S1 A	3S2 A/I	4S1 S	DS1 DS	1R1(b) IR2(b)	2R1(a)	3R1 A/I	4R1 S	6S1(a) D & C			
589	-	173	587	30	1,876	-	-	-	30	1,016			
788	-	252	648	45	2,148	-	-	-	45	2,180			
479	-	141	478	30	1,529	-	-	-	30	1,302			
-	1,529	-	-	-	-	-	-	-	-	-			
-	493	-	-	-	-	-	-	-	-	-			
-	-	-	-	-	-	-	2,062	729	-	-			

NOTE: C = Compost, C/D = Compost or Air Dried Sludge, A = Ash and Char, A/I = Ash and Char and Inerts,
DS = Dewatered Sludge, S = Screenings.

(a) A worst case assumption if marketing strategy is not realized.

(b) No values are shown for Solar Drying (1R1) and DESERT Energy (1R2) projects since public highways would not be used. Disposal would occur within project site.

are applicable only to use of public streets and highways and do not address transportation activities occurring entirely within project boundaries. Additionally, the values shown assume a worst case situation with regard to recycling of compost in that all compost produced under the Centralized Dewatering and Composting (Project 2R1), Decentralized Dewatering and Composting (Project 2S1), and the Baseline No-Project Alternative (Project 6S1) would be landfilled. LA/OMA marketing studies, however, indicate that about 193,900 tons/year of compost could be marketed.

POTENTIAL WATER RELEASE

Estimates of potential water release from sludge at the point of disposal are shown in Table III-14 for each of the alternative sludge management projects. Two basic cases have been defined based upon water release from overburden pressure only and water release from overburden pressure combined with water release associated with biological degradation of about one-third of the dewatered sludge solids after placement in the landfill. Within each case, the nominal depth of overburden is varied to produce the "moderate" and "maximum" conditions.

Derivation of these estimates relies heavily upon the results of the landfill demonstration study conducted for LA/OMA Project by Los Angeles County Sanitation Districts (Ref. 4). It is obvious that organic matter in dewatered sludge will be degraded after placement in the landfill. However, it is evident that the major portion of water release occurs as the result of overburden pressure. It should be noted that the values shown in Table III-14 do not consider absorption of water by refuse already in the landfill or by refuse that is deposited with the sludge. Additionally, the phenomenon of water release would occur over a long period of time as refuse accumulated in the landfill to the assumed depth of overburden. Thus, the water release estimates shown are conservative in terms of the actual potential for leachate production.

Research has found that refuse field capacity (i.e. capacity of in place refuse to absorb moisture) is highly variable. Water retention is directly related to the composition of the refuse, compaction of the completed fill as a result of settlement, and decomposition of organics (both refuse and sludge) after placement in the fill. In a full scale landfill operation, these factors are spatially and temporarily variable. In situ measurements of these factors are generally unavailable. However, the landfill demonstration study has simulated a range of conditions for these factors in a field study (Ref. 4). It is the best information available and the estimates shown in Table III-14 represent a range of estimates that can be used in analysis of leachate production potential.

Considering the safety factors that are included in the analysis and the assumed nominal depth of overburden, the "Overburden/Decomposition" case would approach a worst case situation.

PUBLIC FACILITIES REQUIREMENTS

Varying demands will be exerted upon solid waste management facilities, water supply systems, and LA/OMA operating agency wastewater treatment plants. Mag-

TABLE III-14

ULTIMATE DISPOSITION OF RESIDUALS AND POTENTIAL WATER RELEASE ALTERNATIVE SLUDGE MANAGEMENT PROJECTS

Full Secondary Treatment - Year 2000

PROJECT NO.	AGENCY	TYPE	RESIDUAL		TO MARKET WET WT. tons/day	TO DISPOSAL WET WT. tons/day	ULTIMATE DISPOSITION/ LANDFILL	WATER CONTRIBUTION ^(c) GALLONS PER DAY		MODELS
			SOLIDS	WET WT. (a) tons/day				MARKET	LANDFILL	
251	CLA	Compost	70	349	0 ^(b)	349	Lopez Canyon	0	25,000	
	LACSD	Compost	70	468	468	0	Puente Hills	34,000	0	
	OCSD	Compost	70	284	63	221	Prima Deshecha	4,000	16,000	
	TOTALS			1,101	531	570		38,000	41,000	
251-X	OCSD	Compost/Dried	70	284	0	284	Bee Canyon	0	20,400	
351	CLA	Ash	100	128	0	128	Lopez Canyon	0	0	
	LACSD	Ash	100	187	0	187	Puente Hills	0	0	
	OCSD	Ash	100	104	0	104	Prima Deshecha	0	0	
	TOTALS			419	0	419		0	0	
352	CLA	Ash	100	190	0	190	Lopez Canyon	0	0	
		Inerts	80	134	0	134			6,500	
	LACSD	Ash	100	246	0	246	Puente Hills	0	0	
		Inerts	80	128	0	128			6,200	
	OCSD	Ash	100	155	0	155	Prima Deshecha	0	0	
		Inerts	80	109	0	109		0	5,300	
	TOTALS			962	0	962		0	18,000	
451	CLA	Liquid	3	13,000	0	13,000	Ocean	0	0	
	LACSD	Liquid	3	19,000	0	19,000	Ocean	0	0	
	OCSD	Liquid	3	10,700	0	10,700	Ocean	0	0	
	TOTALS			42,700	0	42,700		0	0	
051	CLA	Cake	23	1,604	0	1,604	Lopez Canyon	0	296,000	188,000
	LACSD	Cake	26	1,819	0	1,819	Puente Hills	0	323,000	184,000
	OCSD	Cake	23	1,304	0	1,304	Prima Deshecha	0	240,000	153,000
	TOTALS			4,727	0	4,727			859,000	525,000
1R1	REGIONAL	Dried Sludge	60	1,903	0	1,903	Offsite Location	0	183,000	
1R2	REGIONAL	Ash	100	419	0	419	Offsite Location	0	0	
2R1	REGIONAL	Compost	70	1,141	531 ⁽¹⁾	610	Milliken	38,000	44,000	
3R1		Ash	100	510	0	510	Milliken	0	0	
		Inerts	80	56	0	56		0	2,600	
	TOTALS			566	0	566			2,600	
4R1	REGIONAL	Liquid	3	42,700	0	42,700	Ocean	0	0	
651	CLA	Cake	18	889	0	889	Lopez Canyon	0	175,000	128,000
	LACSD	Cake	18	1,750	0	1,750	Puente Hills	0	344,000	252,000
		Compost	70	100	100	0		7,000	0	
	OCSD	Cake	18	1,139	417 ^(k)	722	Prima Deshecha	82,000	142,000	104,000
	TOTALS			3,878	517	3,361		89,000	661,000	484,000

NOTE: Assumes that indicated uses of landfills is acceptable to regulatory agencies.

(a) Includes weight of water. Dry weight = wet weight x percent solids as a decimal.

(b) Assumes a marketing strategy which results in 193,000 tons/year of marketed compost in 1990 and that this market remains constant to year 2000.

(c) Gallons per day = $\frac{(\text{Wet Weight} - \text{Dry Weight}) \times 2,000}{8.34}$ (d) Water Release = $\frac{(\text{Wet Weight} - (\text{Wet Weight} \times (\text{Percent Cake Solids} / \text{Percent Solids Nonleaching}))) \times 2,000}{8.34}$

(e) Assumes sludge dewaterers to 45% solids after placement in the landfill and the nominal depth of fill overburden on the sludge reaches 100 feet. (See "Landfill Demonstration Project", May 1978, Exhibit 7-1.)

(f) Projected water release due to overburden pressure only. Assumes that sludge dewaterers to 60% solids after placement in a landfill and the nominal depth of overburden is 330 feet. (Reference: LA/DMA Project, "Draft Report, Landfill Demonstration Project", May 1979, Exhibit 7-1.)

(g) Projected theoretical maximum water release considering effects of elevated temperature within landfills and biological degradation of one-third of solids after placement in the landfill and the nominal depth of overburden is 100 feet.

(h) Projected theoretical maximum water release considering effects of elevated temperature within landfills and biological degradation of one-third of solids after placement in the landfill and the nominal depth of overburden on sludge reaches 330 feet. (Reference: LA/DMA Project, "Draft Report, Landfill Demonstration Project", May 1979, Exhibit 7-2.)

(i) In this case, depth of overburden is assumed to be 100 feet and sludge dewaterers in the landfill to 60% solids. This would be the midpoint of the end of the 20-year planning period and that evaporation during the addition of sludge to the stockpile would reduce the potential.

(k) Assumed to be recycled and marketed by a private contractor.

(l) Assumes a marketing strategy which results in marketing of 193,900 tons/year of compost.

TABLE III-14

ULTIMATE DISPOSITION OF RESIDUALS AND POTENTIAL WATER RELEASE FROM SLUDGE ALTERNATIVE SLUDGE MANAGEMENT PROJECTS

Full Secondary Treatment - Year 2000

TYPE	RESIDUAL		TO MARKET WET WT. tons/day	TO DISPOSAL WET WT. tons/day	ULTIMATE DISPOSITION/ LANDFILL	WATER CONTRIBUTION(c)		POTENTIAL WATER RELEASE (d)			
	SOLIDS	WET WT. (a) tons/day				GALLONS PER DAY		OVERBURDEN		OVERBURDEN/DECOMPOSITION	
						MARKET	LANDFILL	MODERATE (e)	MAXIMUM (f)	MODERATE (g)	MAXIMUM (h)
Compost	70	349	0(b)	349	Lopez Canyon	0	25,000	0	0	0	10,600
Compost	70	468	468	0	Puente Hills	34,000	0	0	0	0	0
Compost	70	284	63	221	Prima Deshecha	4,000	16,000	0	0	0	6,700
		1,101	531	570		38,000	41,000	0	0	0	17,300
Compost/Dried	70	284	0	284	Bee Canyon	0	20,400	0	0	0	8,900
Ash	100	128	0	128	Lopez Canyon	0	0	0	0	0	0
Ash	100	187	0	187	Puente Hills	0	0	0	0	0	0
Ash	100	104	0	104	Prima Deshecha	0	0	0	0	0	0
		419	0	419		0	0	0	0	0	0
Ash	100	190	0	190	Lopez Canyon	0	0	0	0	0	0
Inerts	80	134	0	134		0	6,500	0	0	0	0
Ash	100	246	0	246	Puente Hills	0	0	0	0	0	0
Inerts	80	128	0	128		0	6,200	0	0	0	0
Ash	100	155	0	155	Prima Deshecha	0	0	0	0	0	0
Inerts	80	109	0	109		0	5,300	0	0	0	0
		962	0	962		0	18,000	0	0	0	0
Liquid	3	13,000	0	13,000	Ocean	0	0	0	0	0	0
Liquid	3	19,000	0	19,000	Ocean	0	0	0	0	0	0
Liquid	3	10,700	0	10,700	Ocean	0	0	0	0	0	0
		42,700	0	42,700		0	0	0	0	0	0
Cake	23	1,604	0	1,604	Lopez Canyon	0	296,000	188,000	240,000	258,000	270,000
Cake	26	1,819	0	1,819	Puente Hills	0	323,000	184,000	250,000	274,000	290,000
Cake	23	1,304	0	1,304	Prima Deshecha	0	240,000	153,000	190,000	210,000	220,000
		4,727	0	4,727		0	859,000	525,000	680,000	742,000	780,000
Dried Sludge	60	1,903	0	1,903	Offsite Location	0	183,000	0	0	0(i)	65,000(j)
Ash	100	419	0	419	Offsite Location	0	0	0	0	0	0
Compost	70	1,141	531(1)	610	Milliken	38,000	44,000	0	0	0	18,000
Ash	100	510	0	510	Milliken	0	0	0	0	0	0
Inerts	80	56	0	56		0	2,600	0	0	0	0
		566	0	566		0	2,600	0	0	0	0
Liquid	3	42,700	0	42,700	Ocean	0	0	0	0	0	0
Cake	18	889	0	889	Lopez Canyon	0	175,000	128,000	150,000	158,000	165,000
Cake	18	1,750	0	1,750	Puente Hills	0	344,000	252,000	290,000	312,000	325,000
Compost	70	100	100	0		7,000	0	0	0	0	0
Cake	18	1,139	417(k)	722	Prima Deshecha	82,000	142,000	104,000	121,000	129,000	134,000
		3,878	517	3,361		89,000	661,000	484,000	561,000	599,000	624,000

Indicated uses of landfills is acceptable to regulatory agencies.

Water. Dry weight = wet weight x percent solids as a decimal.

Strategy which results in 193,000 tons/year of marketed compost in 1990 and that this market remains constant to year 2000.

Wet Weight - Dry Weight) x 2,000

8.34

Weight - (Wet Weight x (Percent Cake Solids/Percent Solids Nonleaching))) x 2,000

8.34

Assumes to 45% solids after placement in the landfill and the nominal depth of fill overburden on the sludge reaches 100 feet. (Reference: LA/OMA Project, "Draft Report, Landfill Demonstration Project", May 1978, Exhibit 7-1.)

Assumes due to overburden pressure only. Assumes that sludge dewater to 60% solids after placement in a landfill and the nominal depth of fill or overburden on the sludge reaches 100 feet. (Reference: LA/OMA Project, "Draft Report, Landfill Demonstration Project", May 1979, Exhibit 7-1.)

Assumes maximum water release considering effects of elevated temperature within landfills and biological degradation of one-third of the sludge solids. Assumes sludge dewater to 70% solids in the landfill and the nominal depth of overburden is 100 feet.

Assumes maximum water release considering effects of elevated temperature within landfills and biological degradation of one-third of the sludge solids. Assumes sludge dewater to 80% solids in the landfill and the nominal depth of overburden on sludge reaches 350 feet. (Reference: LA/OMA Project, "Draft Report, Landfill Demonstration Project", May 1978, Exhibit 7-1.)

Assumes overburden is assumed to be 100 feet and sludge dewater in the landfill to 60% solids. This would be the midpoint of the sludge storage pile.

Assumes depth of overburden is assumed to be 100 feet and sludge dewater to 70% solids. It should be noted that the 100-foot depth would, under design assumptions, be reached at the end of the marketing period and that evaporation during the addition of sludge to the stockpile would reduce the potential.

Assumes strategy which results in marketing of 193,900 tons/year of compost.

nitude of such demands are given in Table III-15 for each of the alternative management projects.

All projects would require potable water for digester heating. Significant potable water demands would also be exerted by Project 3R1 (Energy Recovery from Sludge and Dairy Waste) and Project 1R2 (Desert Energy Project), since secondary effluent would not be available. Other projects involving thermal processing could use secondary effluent for cooling and quench water and for exhaust gas scrubbing, however, potable water would be needed for condensate makeup water. Since belt presses have been assumed for mechanical dewatering in certain of the projects, a demand for washwater is created. With the exception of Project 2R1 (Centralized Dewatering and Composting) and Project 3R1 (Energy Recovery from Sludge and Dairy Waste), secondary effluent would be used. Since secondary effluent is unavailable, potable water would need to be used for Project 2R1 and 3R1.

TABLE III-15
PUBLIC FACILITIES DEMANDS
ALTERNATIVE SLUDGE MANAGEMENT PROJECTS

Full Secondary Treatment - Year 2000

Project	Solid Waste Disposal Demands	Wastewater Treatment Demands (a)			Water Supply Demands (b)	
		CLA (MGD)	LACSD (MGD)	OCSD (MGD)	Potable (c) (MGD)	Effluent (d) (MGD)
2S1	570	7.5	8.4	6.1	0.4	7.8
2S1-X (e)	284	-	-	6.1	0.1	2.1
3S1	419	8.7	9.8	7.1	0.5	29.8
3S2	962	8.5	9.5	6.9	0.5	31.2
4S1	85	0	0	0	0.4	0
DS1	4,727	7.4	8.4	6.1	0.4	7.8
1R1	0	4.7	4.2	4.3	0.4	0
1R2	0	5.4	5.0	5.0	2.4	0
2R1	610	7.6	7.2	7.2	8.3	0
3R1	566	9.6	9.1	9.2	43.6	0
4R1	85	0	0	0	0.4	0
6S1	3,361	3.5	4.7	3.4	0.4	0

- (a) From sidestreams produced during sludge processing.
 (b) Water supply demands determined by Daniel, Mann, Johnson & Mendenhall.
 (c) Potable water requirements.
 (d) Secondary effluent can be used to supply these demands.
 (e) OCSD only.

REFERENCES

III- 34 (A)

TEXT REFERENCES

1. Garrison, W.E. to Bill Davis, letter dated August 27, 1979.
2. Gruen Gruen + Associates. 1979. Marketing Programs Designed for Sludge Management., Report to LA/OMA Project.
3. LA/OMA Project. 1980. Quantitative Analysis of Sludge Management Projects.
4. County Sanitation Districts of Los Angeles County. 1979. Landfill Demonstration Project., Report to LA/OMA Project.

CHAPTER IV

CHAPTER I

**BACKGROUND AND
PROBLEM DESCRIPTION**

CHAPTER II

**DEVELOPMENT OF THE
ALTERNATIVE SLUDGE
MANAGEMENT PROJECTS**

CHAPTER III

**DESCRIPTION OF THE
ALTERNATIVE SLUDGE
MANAGEMENT PROJECTS**

CHAPTER IV

**COMPARATIVE EVALUATION
OF THE SLUDGE
MANAGEMENT PROJECTS**

CHAPTER V

**DESCRIPTION OF THE
PROPOSED SLUDGE
MANAGEMENT PROGRAM**

CHAPTER VI

**DETAILED PHASE II
FACILITY DESCRIPTIONS**

CHAPTER VII

ANALYSIS OF KEY TOPICS

APPENDICES**CHAPTER IV**

**COMPARATIVE EVALUATION
OF THE SLUDGE
MANAGEMENT PROJECTS**

- **QUANTITATIVE ANALYSIS**
- **ENGINEERING PRACTICABILITY**
- **IMPLEMENTATION POTENTIAL**
- **ENVIRONMENTAL ACCEPTABILITY**
- **ADVANTAGES/DISADVANTAGES**
- **CONCLUSIONS**

CHAPTER IV

COMPARATIVE EVALUATION OF THE SLUDGE MANAGEMENT PROJECTS

The projects defined in Chapter III were the last group of alternatives studied before defining the recommended sludge management program. The projects were subject to very detailed and technical studies with the purpose of developing a data base for the comparative analysis.

The projects were the focus of studies in the following considerations:

- Environmental Acceptability
- Implementation Potential (including Public Participation)
- Qualitative Engineering Analysis (Practicality)
- Quantitative Engineering Analysis

Results of the studies were compiled into several detailed documents referenced at the end of the chapter. Conclusions and other highly significant information have been extracted for this report. Every effort has been made to avoid loss of information important to the analysis. However, the analysis presented in the chapter is a summary. If additional information is needed, the individual evaluation reports should be consulted.

The evaluation provided the data base for the comparative analysis. The outcome of the comparison of one project to another was the identification of important differences between the alternatives. Knowing the differences allowed the levels of risks and benefits to be assessed, thus leading to the recommendation of the sludge management program.

As part of the procedure leading to selection of the management plan, all projects were rank ordered for each consideration. The rank ordering for each

consideration and the underlying reasons for a particular ranking are included in this chapter. Should the reader disagree with a particular ranking or judgment decision, it should be possible to assess the significance of changes in rank ordering on final plan selection.

COMPARATIVE EVALUATION OF THE BRIDGE MANAGEMENT PROJECTS

The purpose of this chapter is to provide a comparative evaluation of the bridge management projects. The evaluation is based on the results of the project evaluation and the results of the project evaluation. The evaluation is based on the results of the project evaluation and the results of the project evaluation.

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QUANTITATIVE ANALYSIS

This consideration includes the significant quantitative information developed for the projects including the following: (1) capital and operating costs and credits; (2) energy balances, including electrical energy consumption and production, and use of fossil fuels; (3) air emissions, including direct project emissions, offsets from electrical power production, and emissions tradeoffs; (4) present worth analysis for both 20 and 40 year project life; (5) a sensitivity analysis which examined many operating variables and other factors such as inflation; (6) an assessment of the mass flow of toxicants and health risks resulting from each project; and (7) other factors such as number of employees, land requirements, plant layouts, and an assessment of odor potential. Major conclusions of the economic, energy, and air emission analysis will be presented here.

The following definitions are useful to understanding of material presented in this section.

Total Capital Cost

Total capital cost required to construct the Sludge Management Project, based on an ENR of 3031 and excluding existing digester capacity. Includes installed process or equipment costs, structural or building costs, and land purchase costs.

Annual Capital Cost

Amortized capital cost. All capital costs, except rolling machinery (trucks), are amortized per state guidelines at 6-5/8 percent and 20 years. Trucks are amortized at 6-5/8 percent and 5 years, and windrow composting machinery at 6-5/8 percent and 10 years. Note that the amortization rates have since been revised by the State. Those shown were in effect at the time of the analysis.

O & M

Current* annual cost of operation and maintenance for the project based on a Consumer Price Index of 183. Includes costs for labor, chemical, energy, maintenance, dump charges, and liquid sidestream treatment for all unit processes in the treatment train.

* The ENR and CPI index are actually adjusted to about August 1977 levels. The term current annual cost has been used for convenience but should be implied to mean August 1977 costs.

Credits

Current annual value placed on by-products recovered during sludge processing. Major items include produced electricity valued at 3¢/KWH, compost at \$2.00 per wet ton, and tipping fees for refuse received at an REF processing facility at \$8/wet ton.

Annual Net Cost

Sum of annual capital and O & M costs less annual value of credits.

Unit Net Cost

Total net annual cost divided by the annual production of raw sludge. Units should read as dollars/dry ton of raw sludge.

Net Cost-Agency Share

Current annual cost of the project to the local operating agency. Includes 100 percent of O & M costs and credits and 12.5 percent of total annual capital cost, except for Projects 4S1 and 4R1 for which 100 percent of total annual capital cost was assumed. All capital costs were assumed to be grant eligible except those associated with Projects 4S1 and 4R1 which were assumed to be non-grant eligible.

Present Worth 40 Year

Present worth of capital, O & M, and credits for a 40 year project life, zero salvage value at end of the period, and inflation at 8 percent per year. Digesters, pipelines (not including pump stations), and solar drying basins were assumed to have a 40 year service life. All other equipment was assumed to have the service life previously described under "Annual Capital" and was replaced as necessary during the 40 year project life. Equivalent implementation delays were assumed for all projects.

Present Worth - Interim plus Base

Present worth of capital, O & M, and credits for a 47 year project including an implementation period during which the interim project is operated followed by construction and operation of the base project. Implementation periods were assumed at 7 years for in-plant projects, 10 years for regional in-basin projects, and 15 years for regional out-of-basin projects. Inflation was at 8 percent with service lives as described under "Present Worth-40 Years". This analysis is perhaps the most inclusive since effects of inflation, differing service lives, and different implementation periods are considered.

Year 20 Cost

Annual cost expected in the 20th year of a project if constructed today. Inflation at 8 percent is assumed for all O & M components and credits. Annual capital costs were fixed at current amortized values.

Net Electricity

Net electrical energy production in KWH/day from the sludge processing train, calculated as the total electricity produced less that required for sludge processing. Electricity production is assumed to result from use of digester gas and from thermal processing of sludge solids. Effects of steam routing for digester heating and sludge drying are included.

Electrical Equivalent of Fuels Used

Value shown is the electrical equivalent of organics used in the project including diesel fuel, fuel oil, isopar, and polymer. Calculated assuming 10,387 BTU/KWH.

Net Direct Energy

Net electricity production less the electrical equivalent of fuels used in the project. Does not include secondary or indirect energy consumption or production such as energy required to produce building materials or energy required for construction.

Energy-Total

Includes net direct energy and certain secondary energy benefits such as enhanced landfill gas generation and the energy equivalent of recycled fertilizer nutrients.

Air Emission-Direct

Sum total of air emissions resulting from the project including combustion of digester gas, combustion of sludge solids by thermal processing, and operation of mobile equipment such as trucks, composters, etc.

Air Emissions-Net

Direct air emissions less the air emissions expected if an electrical utility were to generate the same quantity of net electricity. Since electrical power must be generated to meet secondary treatment demands, this heading represents most closely the net effect on the air basin from implementation of the project.

Based on the process flow diagrams and site locations described in Chapter III, the Alternative Sludge Management Projects (SMP) were analyzed in detail using the computer program described in Appendix B. Tabulated information on economic, sizing, and energy factors for each SMP is presented in Appendix A. The latter information can be used to supplement the following discussion of quantitative factors.

ECONOMIC ANALYSIS

COST ESTIMATING METHODOLOGY

Cost estimating methodologies vary based on purpose or intended use of the estimate, and the depth or detail of the information on which to base the estimate. The cost estimating methodology used in evaluating the capital, operating and maintenance costs and credits of the various unit processes contained in the alternative Sludge Management Projects is described in the following.

All capital costs for the unit processes are adjusted to an Engineering News Record (ENR) Index of 3031 (August, 1977). Equipment and land is amortized at 6-5/8 percent for 20 years, with the exception of trucks and windrow composting machinery. These two types of equipment are amortized at 5 and 10 years, respectively. Land cost factors are assigned to a number of the unit processes when the unit process does not occur on public right-of-way or land owned by one of the agencies.

The purpose of the economic analysis was to allow for an "Order of Magnitude" cost comparison between a large number of alternative Projects. The relative costs between the various permutations, rather than the actual costs, are therefore of primary concern. An "Order of Magnitude" cost comparison provided sufficient accuracy to make the relative comparisons. No advantages in comparing the permutations would have been gained by performing "Budget" or "Definitive" level cost comparisons.

Information used to develop the cost factors was drawn from previous LA/OMA reports, sanitary engineering literature, and records of the LA/OMA agencies, very preliminary designs, as well as the files of equipment suppliers and private consultants. Such information, when appropriately updated, forms a sound basis for "Order-of-Magnitude" estimates for sludge processing costs.

In actual practice, "Order of Magnitude" estimates tend to be 20 to 40 percent below the actual cost at bid time, excluding inflation. The under estimation of actual capital costs tends to occur because:

1. The design is not fully enough developed to identify all the components that are a part of the project. For example, electrical and instrumentation and control costs can account for 15 to 20 percent of the capital costs.
2. As the design progresses and more information is developed about the flexibility of the unit processes, its capacity, and the manufacturer's scope of supply, the design expands over that originally envisioned and hence becomes more costly.
3. The tendency of some suppliers to underestimate their actual costs either based upon a desire to market a product or in ignorance of the intended use of their products in a particular application.

To help insure that the "Order of Magnitude" costs used in the cost analysis are as representative as possible of the actual capital costs exclusive of inflation, contingencies have been applied to the estimated unit process costs. The rationale used to develop the contingencies for the various unit processes is as follows:

Estimates based upon previous designs of similar size by the consultant, using conventional equipment.	30%
Estimates based upon information from suppliers having extensive U.S. sewage treatment plant experience.	35%
Estimates based upon information from equipment suppliers with little U.S. sewage treatment plant experience.	40%
Estimates based on a preliminary design by the consultant for a unit process that has had some previous application in wastewater treatment.	35%
Estimates based upon a preliminary design by the consultant for a unit process that has had limited previous application in wastewater treatment.	40%
Estimates for very simple systems involving little detail or for land costs.	20%

Contingency factors applied to the unit processes included as part of the Sludge Management Projects are as follows:

	<u>Contingency Percent</u>
Dissolved Air Flotation Thickening	30
Anaerobic Digestion	30
Centrifuge Dewatering	35
Belt Press Dewatering	40
Carver-Greenfield Dehydration	40
RDF Processing	40
Pipeline Transport	30
Solar Drying Ponds	40
Windrow Sludge Composting	35
Mechanical Sludge Composting	40
Truck Transport	20
Recycle Center	20
Combined Cycle Power Generation	40
Land Costs	20
Direct Fired Thermal Processing	35

Operation and maintenance (O & M) cost factors were developed for each unit process shown above. Cost factors which did not vary between unit processes are shown below. All operation and maintenance costs are based on a Consumer Price Index (CPI) of 183.

<u>Factor</u>	<u>Value</u>
Labor	\$12.50/hr
Diesel Fuel	\$0.40/gal
Low Sulfur Fuel Oil	\$0.40/gal
Electricity	\$0.03/KWh

<u>Factor</u>	<u>Value</u>
Polymers	\$2.00/lb
Isopar-L	\$0.70/gal
Maintenance	varies*
O ₂ Costs for Recycled Wastes	\$22.00/ton O ₂
Dump Charge	\$2.50/wet ton

Operation and maintenance credit factors are applied to a number of the unit processes. Credits from the sale of compost are assigned to the Sludge Recycle Center costs. Credits for the value of electricity are assigned to Combined Cycle Power Generation for use of digester gas and to Direct Fired Thermal Processing for energy recovery from the digested solids. A tipping fee credit for refuse received at the RDF processing facility and a resale credit for recovered ferrous iron were also applied. These credits were intended to recognize the value of resources recovered as part of a management project. Assumed O & M credit factors are as follows:

<u>Factor</u>	<u>Value</u>
Sale of Compost	\$2.00/wet ton
Value of Electricity	\$0.03/KWH
Refuse Tipping Fee	\$10.00/wet ton received
Refuse Resale (Ferrous Metal)	\$35.00/ton received

At least in the case of electricity, the assigned credit does not imply that produced electricity would be sold and cash revenues received by the operating agency. Produced electricity will likely be used within the wastewater treatment plant. But such use will offset the purchase of additional outside power. Therefore, the electrical credit represents the value of a recovered resource and a cost savings to the agencies for not having to purchase the equivalent power from outside sources.

* The cost of labor to the agency is \$12.50 per hour. This figure includes all labor benefits plus an allowance for supervisory personnel. The actual cost to the agency to staff one position per year is \$43,333. A position entails a commitment of 8 man-hours per work position per day.

SUMMARY OF RESULTS

Capital costs and annual operating costs for the Sludge Management Projects under conditions of full and partial secondary treatment are presented in Table IV-1. Current annual costs on a regional basis for full and marine secondary treatment are shown in Figures IV-1 and IV-2, respectively. Costs include all operations in the sludge treatment train including processing, ~~transportation~~, ultimate disposal, sidestream treatment, and energy production. Referring to Figure IV-1, the Long Distance Transport, Composting, and Thermal Processing Projects fall within a fairly narrow band of current annual net costs. The range is from \$37 million/yr. to \$49 million/yr., or about 32 percent cost differential. Landfill disposal (DSI) is currently less expensive on an annual cost basis. The net cost of barge transport outside the Bight is equivalent to that for landfill disposal but other ocean disposal alternatives are projected to be less expensive.

The above trends change somewhat when only agency costs are considered. Agency costs were estimated at 12.5 percent of annual capital costs plus 100 percent of all O & M costs and credits with the exception of ocean disposal alternatives for which the operating agencies were assumed to bear 100 percent of all costs. Under these conditions, the regional solar drying projects become the least cost alternatives. Ocean disposal (assuming no state-federal grant assistance) and landfill disposal (no credit for landfill gas) would be the most expensive projects. If ocean disposal projects are considered grant eligible, ocean disposal in an outfall would become the least cost alternative.

Landfill disposal (DSI) is the most expensive alternative from an agency cost standpoint. The possibility exists that landfilling of dewatered sludge will enhance fuel gas production from a landfill site. Based on estimates of the quantity of enhanced gas production and an assumed credit of \$2/mmBtu, landfill disposal could become a low cost solution in terms of agency costs. In fact, under certain conditions the net agency cost could rival that of ocean disposal via a sludge outfall. It must be recognized that such projections, while based on theoretically sound arguments, are nonetheless preliminary and field testing will be necessary to verify associated cost projections.

Current annual costs for in-plant projects at each individual treatment plant follow the same general pattern as described above. Total annual costs for thermal processing alternatives are somewhat greater than for composting or landfill disposal alternatives. On an agency cost basis, however, the composting and thermal processing alternatives are very similar in cost. Landfill disposal is the most expensive on an agency cost basis but can become one of the least expensive if landfill gas is credited. Ocean disposal via sludge outfall is the least cost alternative except in certain cases where landfill gas is credited.

Costs of sludge processing under marine secondary conditions are significantly reduced compared to the case with full secondary treatment. Annual costs savings range from \$4.5 to 16.5 million/yr on a regional basis. Even though the cost

TABLE IV-1

**ECONOMIC CHARACTERISTICS
ALTERNATIVE SLUDGE MANAGEMENT PROJECT**

(Costs are in thousands of dollars)
Full Secondary Treatment - Year 2000

Project No.	Total Capital Cost	Annual Capital Cost		Annual Operating Cost	Annual Credits(b)	Net Annual Operating Cost(c)		Net Annual Cost(d)
		Total	Local(a)			Operating Cost	Cost	
251	268,200	24,600	3,100	24,100	9,100	15,000		39,600
251-X(e)	51,600	5,100	700	7,700	2,400	5,300		10,400
351	308,300	28,400	3,600	29,000	14,700	14,300		42,700
352	403,200	37,400	4,700	35,900	24,100	11,800		49,200
451	198,900	17,900	17,900	9,300	8,500	8,800		18,700
DS1	157,100	15,700	2,000	30,000	8,800	21,200		36,900
1R1	398,000	36,600	4,600	16,500	8,500	8,000		44,600
1R2	466,400	42,900	5,400	18,400	14,600	3,800		46,700
2R1	257,500	23,700	3,000	23,300	9,700	13,600		37,300
3R1	587,200	32,900	4,100	30,500	18,000	12,500		45,400
4R1	197,500	18,100	18,100	15,000	8,500	6,500		24,600
6S1	145,000	14,000	1,800	22,900	9,300	13,600		27,600
Partial Secondary Treatment - Year 2000								
251	185,200	17,000	2,100	18,700	8,300	10,400		27,400
251-X	28,700	2,900	400	5,500	2,200	3,300		6,200
351	223,900	20,700	2,600	22,400	13,000	9,400		30,100
352	268,500	24,900	3,100	26,100	18,300	7,800		32,700
451	140,000	12,800	12,800	6,900	7,800	-900		11,900
DS1	91,400	9,400	1,200	22,100	8,100	14,000		23,400
1R1	292,200	26,900	3,400	13,100	7,800	5,300		32,200
1R2	360,300	33,100	4,100	14,900	12,700	2,200		35,300
2R1	173,400	15,900	2,000	17,300	8,800	8,500		24,400
3R1	272,800	25,100	3,100	24,200	16,300	7,900		33,000
4R1	141,600	13,000	13,000	12,900	7,800	5,100		18,100
6S1	88,400	9,000	1,100	22,500	8,700	13,800		22,800

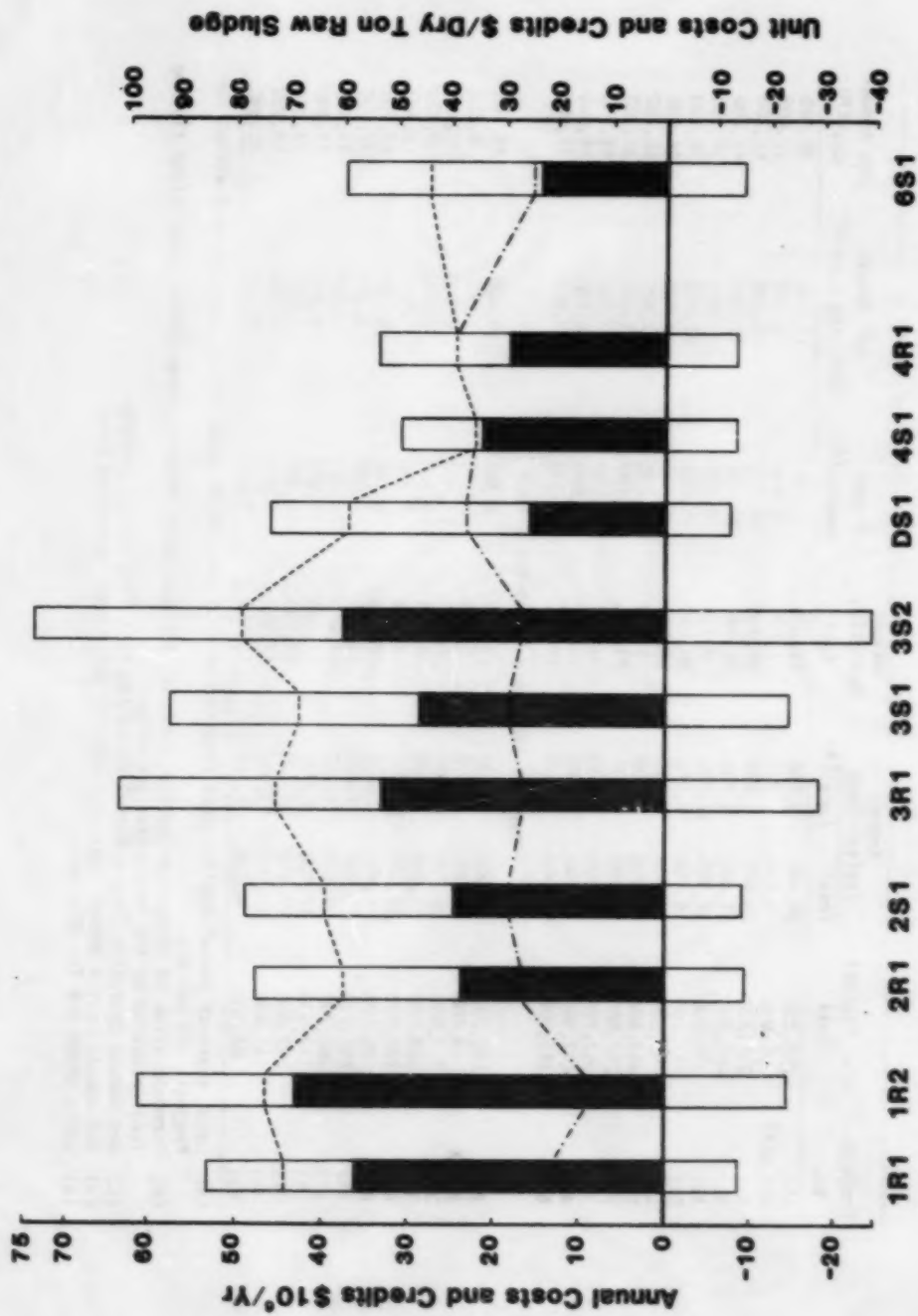
(a) Local share of annual capital cost computed at 12.5 percent of total annual capital cost except for Projects 4S1 and 4R1.

(b) Economic value of resources (energy, compost, ferrous metal recovery from refuse, and refuse tipping fee) recovered by the respective projects.

(c) Net Annual Operating Cost = Annual Operating Cost less Annual Credits

(d) Net Annual Cost = Annual Capital Cost plus Net Annual Operating Cost.

(e) Costs shown are for OCSD only.

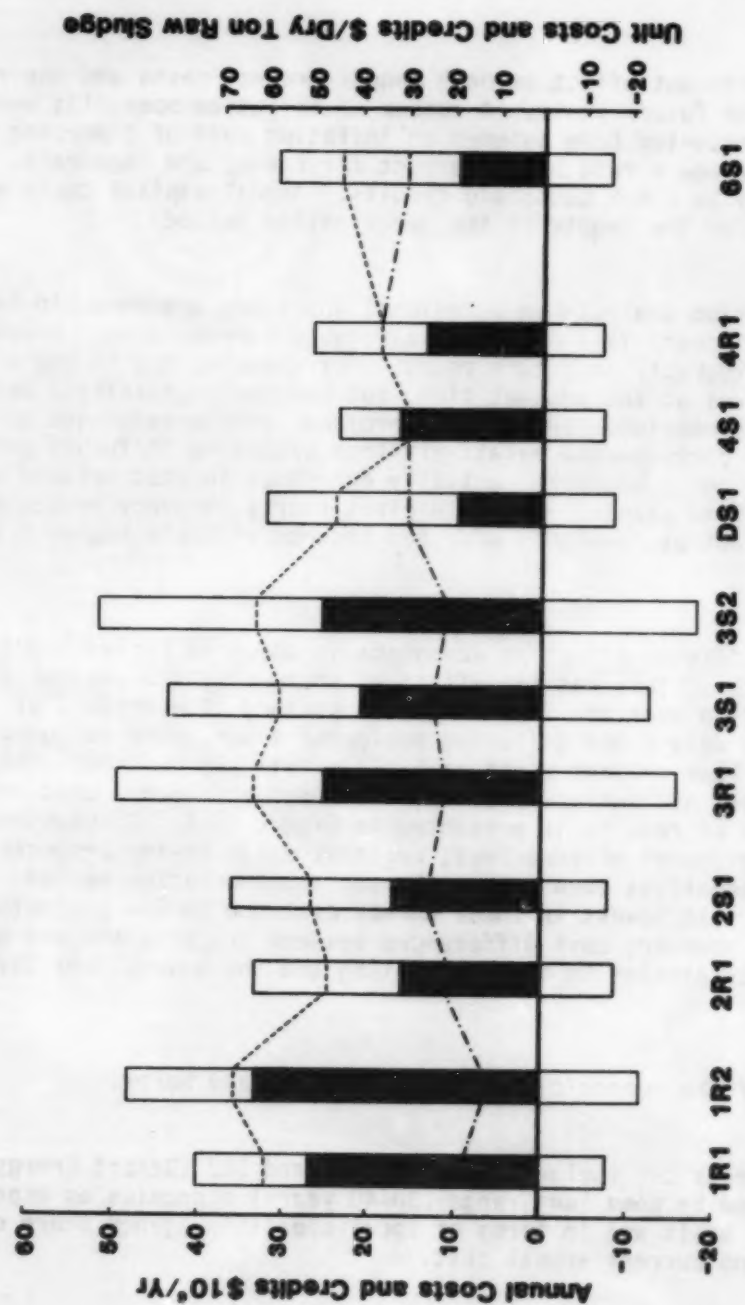


**COST ANALYSIS-LA/OMA SLUDGE
MANAGEMENT PROJECTS**
FULL SECONDARY TREATMENT
REGIONAL SLUDGE MANAGEMENT PROGRAM
LOS ANGELES/Orange COUNTY METROPOLITAN AREA

FIG. IV-1

KEY

- O&M COSTS/CREDITS
- CAPITAL COSTS
- NET TOTAL
- AGENCY COSTS



KEY

□ O&M COSTS/CREDITS

■ CAPITAL COSTS

--- NET TOTAL

--- AGENCY COSTS

**COST ANALYSIS-LA/OMA SLUDGE
MANAGEMENT PROJECT**

PARTIAL SECONDARY TREATMENT

FIG. IV-2

REGIONAL SLUDGE MANAGEMENT PROGRAM
LOS ANGELES/Orange COUNTY METROPOLITAN AREA

savings are quite significant, rank ordering of the projects remains relatively unchanged.

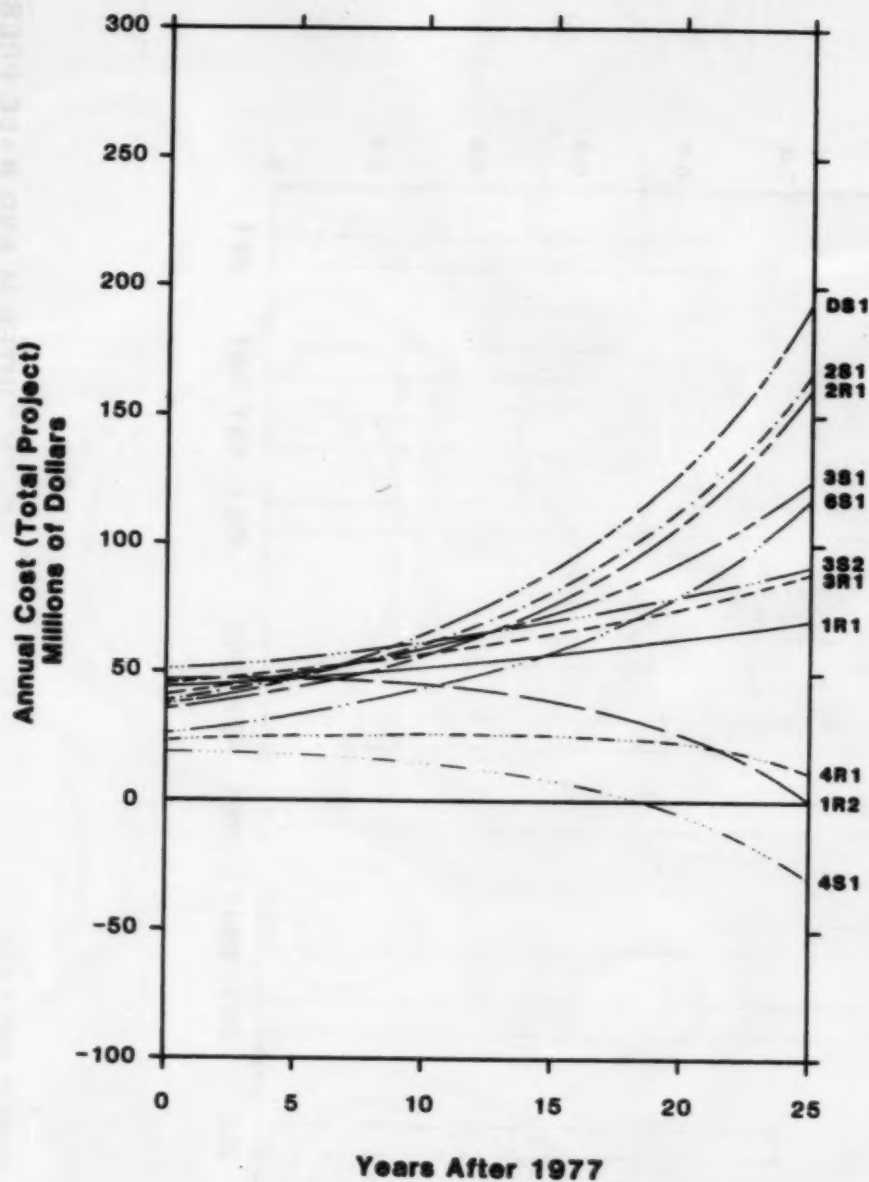
Inflation has a significant effect on both annual project costs and the relative ranking of projects in future years. A number of inflation scenarios were examined. The one presented here assumes an inflation rate of 8 percent for labor and maintenance and a rate of 12 percent for energy and chemicals. Inflation was applied only to O & M costs and credits. Annual capital costs were assumed to be fixed for the length of the amortization period.

Results of the inflation analysis on a regional basis are presented in Figure IV-3. Current annual costs fall within a reasonably narrow range. However, this range increases considerably in future years. For example, DS1 is one of the lower cost alternatives at the present time, but becomes increasingly expensive under the inflation scenarios. In general, projects with greater energy production and lower O & M costs become relatively less expensive in future years. Project 1R2, Desert Energy Recovery, actually decreases in cost because of its power production and low chemical use. In plant energy recovery processes, such as 3S1 and 3S2, are not as favorably effected because of their higher O & M expenses.

The other major sensitivity effecting economics is the time period required for project implementation. This has the effect of increasing the capital cost due to effects of inflation over the implementation period. The effects of inflation, implementation delays and differing equipment lives, were included as part of the interim plus base present worth analysis previously defined. The latter is considered the most all inclusive of the different approaches used in economic analysis. A summary of results is presented in Figure IV-4. Discounting the baseline and ocean disposal alternatives, regional solar drying projects rank as the lowest cost alternatives even with a 15 year implementation period. Solar drying projects are also lowest in local agency cost due to low projected O & M for these systems. However, cost differences between projects are not great considering the uncertainties in cost estimating and the assumptions involved in the analysis.

Major conclusions of the economic analysis are summarized below.

1. The desert Projects 1R1 (Solar Drying Basins) and 1R2 (Desert Energy Recovery) are characterized by good long range (30-40 years) economics as expressed on a present worth basis and in terms of local operating agency share of the present worth and current annual cost.
2. Projects 2S1 (Dewatering and Composting by each Agency), 3S1 (Energy Recovery from Sludge), and 3S2 (Energy Recovery from Sludge and Solid Waste), are characterized by mid range short and long term economics. These projects are



Note: Based on costs beginning in August 1978

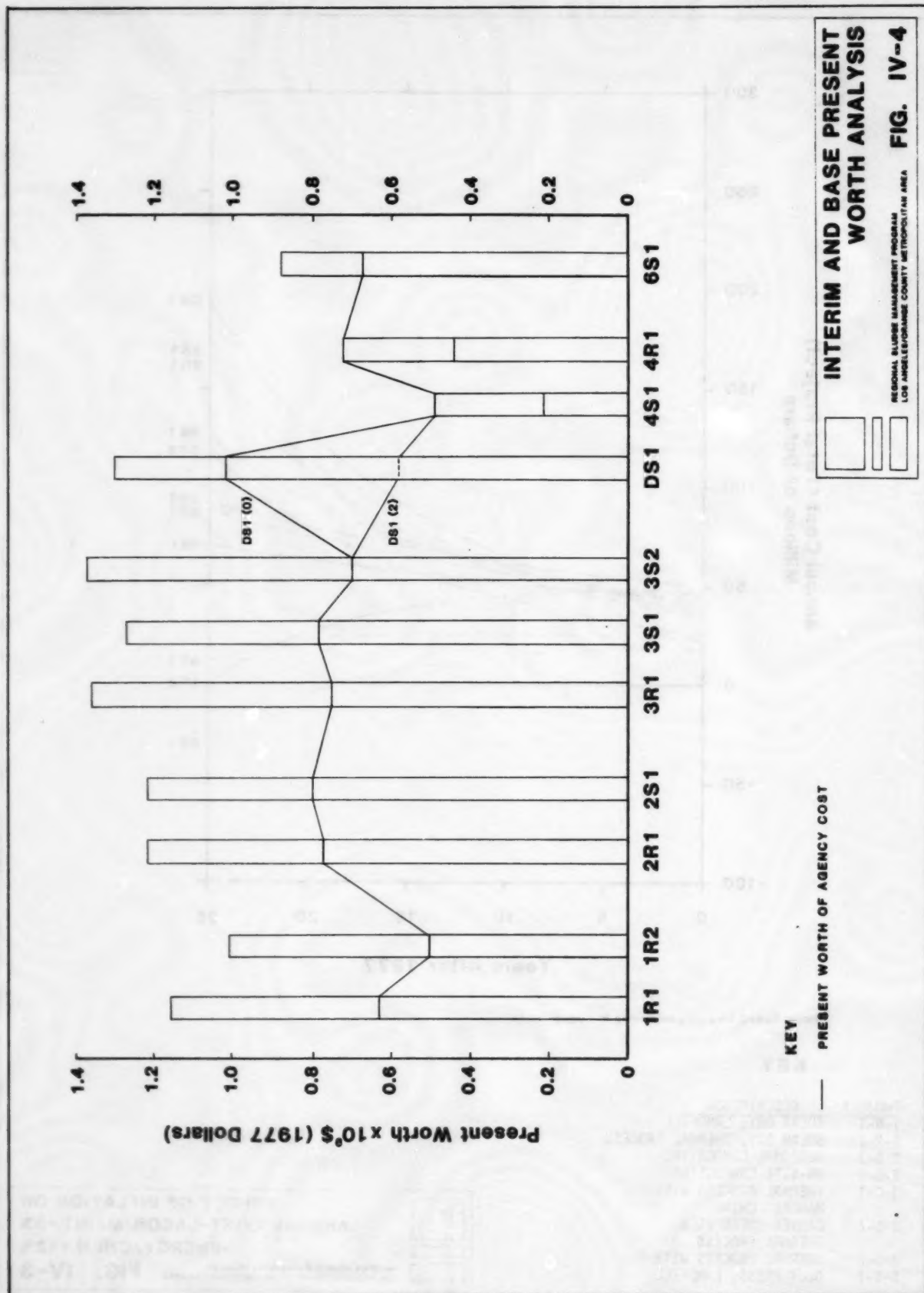
KEY

PROJECT	DESCRIPTION
1-R-1	SOLAR DRY, LANDFILL
1-R-2	SOLAR DRY, THERMAL PROCESS
2-R-1	REGIONAL COMPOSTING
2-S-1	ON-SITE COMPOSTING
3-R-1	THERMAL PROCESS WITH MANURE CHINO
3-S-1	CARVER-GREENFIELD, THERMAL PROCESS
3-S-2	THERMAL PROCESS WITH RDF
D-S-1	BELT PRESS, LANDFILL

**EFFECT OF INFLATION ON ANNUAL COST-LABOR/MAINT.-8%
-ENERGY/CHEM.-12%**

REGIONAL SLUDGE MANAGEMENT PROGRAM
LOS ANGELES-ORANGE COUNTY METROPOLITAN AREA

FIG. IV-3



also generally equivalent on a present worth basis and in terms of the local operating agency share of total annual cost and present worth.

3. Projects 2S1 (Decentralized Dewatering and Composting), 3S1 (Energy Recovery From Sludge), and DS1 (Truck Dewatered Sludge to Landfill) are generally equivalent in terms of current total annual costs.
4. Project DS1 (Truck Dewatered Sludge to Landfills) is characterized by a low capital cost but poor long range economics. It is the least cost alternative on a current, total annual cost basis, excluding ocean disposal alternatives. However, depending on the level of future inflation, it can be the most expensive project within 8 to 12 years if landfill gas is not recovered and used. However, landfill disposal can be either the most or least expensive alternative depending on the quantity and value of enhanced landfill gas generation due to the addition of sludge organic matter, moisture, nutrients, and alkalinity to the landfill.
5. On the basis of current, total, annual costs and discounting the baseline and ocean disposal alternatives, the top 5 projects in order of least cost are Truck Dewatered Sludge to Landfill (DS1), Centralized Dewatering and Composting (2R1), Decentralized Dewatering and Composting (2S1), Energy Recovery from Sludge (3S1), and Solar Drying Basins (1R1). If ocean disposal alternatives (4S1 and 4R1), and the Baseline (6S1) are included, they would rank 1, 2, and 3 in order of lowest annual cost (DS1 crediting landfill gas at \$2/mmBtu included).
6. On the basis of operating agency share of current, total, annual costs and excluding the baseline and ocean disposal alternatives, the top 5 projects in order of least cost are Desert Energy Recovery (1R2), Solar Drying Basins (1R1), Energy Recovery from Sludge and Solid Waste (3S2), Centralized Dewatering Composting (2R1), and Energy Recovery from Sludge and Dairy Waste (3R1). Landfill disposal would occupy the 2nd position if landfill gas were credited at \$2/mmBtu.
7. On the basis of interim plus base present worth and excluding the baseline and ocean disposal alternatives, the top 5 projects in order of least cost are Desert Energy Recovery (1R2), Solar Drying Basins (1R1), Centralized Dewatering and Composting (2R1), Decentralized Dewatering and Composting (2S1), and Energy Recovery from Sludge (3S1). Landfill disposal would occupy the 1st position if landfill gas were credited at \$2/mmBtu. The interim plus base present worth includes effects of inflation, implementation delays, and differing equipment service lives.
8. On the basis of year 20 annual costs and excluding the baseline and ocean disposal alternatives, the top 5 projects in order of least cost are Desert Energy Recovery (1R2), Solar Drying Basins (1R1), Energy Recovery from Sludge

and Solid Waste (3S2), Centralized Dewatering and Composting (2R1), and Energy Recovery from Sludge (3S1). Truck Dewatered Sludge to Landfill (DS1) would occupy the 2nd position if landfill gas is credited at \$2/mmBtu.

9. Major sensitivities affecting project costs are the level of secondary treatment, inflation, implementation delays, and enhanced landfill gas production due to sludge disposal.
10. Marine secondary treatment levels would significantly reduce costs of sludge management but not significantly change the ranking of projects on a regional annual cost basis.
11. Inflation has significant effect on both annual project costs and the relative ranking of projects in future years. Projects which are lower in O & M cost and/or produce greater energy credits are more insulated from inflationary effects. With an annual inflation of 8 percent per year, the cost difference between the first and second ranked projects in year 20 is greater than the entire range of current costs for all Projects. Effects of inflation are included in the rankings discussed in conclusions 7 and 8.
12. Implementation delays can cause momentary changes in the ranking of projects. Year 20 annual costs are significantly influenced by the implementation period. The effect is temporary, however, when equipment replacement is considered and is largely erased by year 30. Project rankings in year 30 with implementation delays considered are similar to rankings in year 20 without any implementation delay.
13. The following sensitivities were examined and, while they can have a definite impact on project costs, are expected to be less significant than those previously discussed and to have less significant impacts on project rankings; interest rates, equipment amortization period, polymer dosage, amount of compost recycle, Carver-Greenfield oil loss, Carver-Greenfield energy efficiency, lining of solar drying basins, performance of flotation thickening, cake solids from dewatering, flotation thickening after digestion, and percent solids infeed to composting. Most of the sensitivities result in project cost increases in the range of 1 to 13 percent.
14. Several modifications to the base projects were evaluated with the following specific conclusions:
 - a. Project 2S1B - Inclusion of Carver-Greenfield drying as part of the process train (2S1 base) appears to increase total project costs compared to direct composting of dewatered cake (2S1B), but does reduce the composting land requirements. If improved composting techniques are used to overcome thermodynamic limitations and if land requirements are

not limiting, direct composting of dewatered cake may be the system of choice compared to 2S1 (base).

- b. Project 2S1C - Both Projects 2S1B and 2S1C (windrow composting) have current total annual costs which are less than 2S1 (base). Projected effects of inflation indicate that 2S1B and 2S1C will become essentially equivalent in cost and remain less expensive than 2S1 (Base). This suggests that current cost difference between windrow and mechanical composting will decrease as inflation continues.
- c. Project 3S2B - Addition of Carver-Greenfield drying for the sludge component reduces the capital cost of thermal processing with refuse and increases the annual energy credit. Current total annual costs are reduced by about 15 percent compared to 3S2 (base). 3S2B will remain less expensive than 3S2 (base) under the inflation scenarios examined.
- d. Project 3S1B - Use of the Purox converter in place of a multiple hearth furnace is projected to increase current, total annual costs by about 26 percent. However, Project 3R1B produces higher energy credits and future increases in the value of energy are likely to decrease the cost difference between the two projects.

ENERGY ANALYSIS

Anaerobic digestion produces methane and other gases which are assumed to be used for digester heating and in a combined cycle system for electrical power production. In some projects the residue from anaerobic digestion is thermally processed either alone or with refuse or dairy manure. Hot flue gases produced during thermal processing would be used in a waste heat boiler to first generate steam and then electricity in a steam turbine. When applicable, some of the steam can be used to operate sludge dehydration devices.

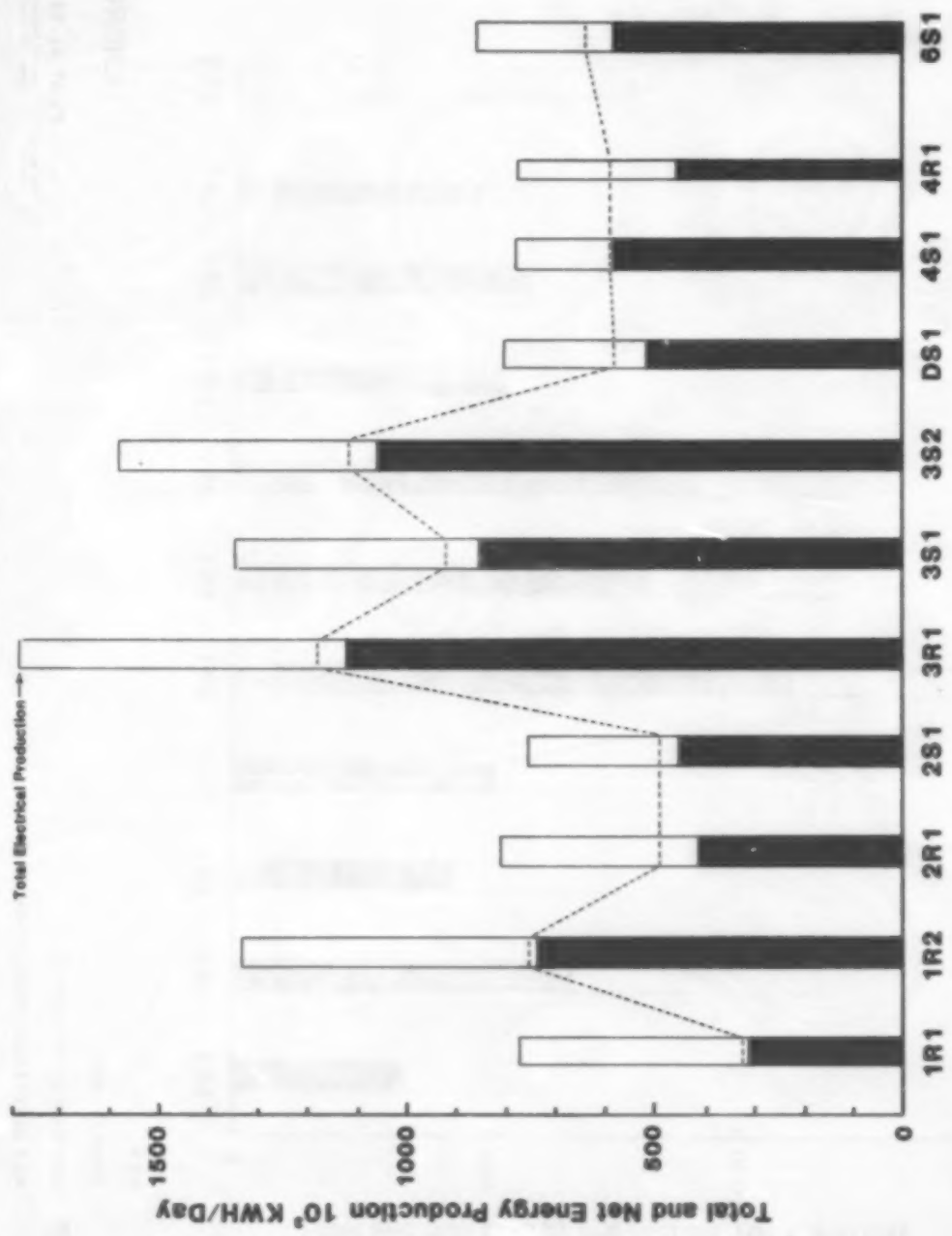
Fuel oil will not generally be needed for sludge processing since most steam requirements can be satisfied from the combined cycle or thermal processing systems. However, diesel fuel will be needed for all mobile equipment including trucks, composting equipment, and barges.

Energy production and use data for the different sludge management projects is presented in Table IV-2 and in Figures IV-5 and IV-6 for the cases of full and partial secondary treatment, respectively. In this discussion the term "net electricity" refers to total produced electricity less any electricity used in the sludge processing system. The term "net energy" refers to the net electricity less the electrical equivalent of diesel fuel, fuel oil, and polymer organics. The base level of total electrical production from digester gas use would be about 750,000 KWH/day on a regional basis with full secondary treatment.

TABLE IV-2
ENERGY CHARACTERISTICS
ALTERNATIVE SLUDGE MANAGEMENT PROJECTS
(Thousands of KWH/Day)
Full Secondary Treatment - Year 2000

Project No.	Electrical Production	Electrical Consumption	Fuel & Chemical Usage (a)	Net Direct Energy (b)	Secondary Energy Benefit (c)	Net Total Energy (d)
251	753	265	36	450	70	520
251-X(e)	203	63	32	108	0	108
351	1,344	427	60	858	0	858
352	1,583	467	53	1,063	0	1,063
451	774	188	4	583	0	583
051	803	222	64	517	0	517(f)
1R1	774	454	7	313	0	313(g)
1R2	1,332	585	8	739	0	739
2R1	803	312	81	410	70	480
3R1	1,778	597	62	1,120	0	1,120
4R1	774	183	133	458	0	458
651	850	210	57	583	10	593
Partial Secondary Treatment - Year 2000						
(10 ³ KWH/DAY)						
251	720	184	25	511	57	568
251-X(e)	183	44	22	117	0	117
351	1,188	316	55	817	0	817
352	1,281	331	35	914	0	914
451	716	135	3	579	0	579
051	739	163	47	530	0	530
1R1	716	379	5	332	0	332(g)
1R2	1,157	482	6	669	0	669
2R1	739	251	57	432	57	489
3R1	1,620	481	30	1,077	0	1,077
4R1	716	135	3	579	0	579
651	785	161	55	569	10	579

- (a) Includes fuel oil, diesel fuel, and chemicals used in sludge processing.
 (b) Net Direct Energy = (Electrical Production) - (Electrical Consumption) - (Fuel and Chemical Usage).
 (c) Secondary energy benefits resulting from reuse of composted sludge.
 (d) Net Total Energy = (Net Direct Energy) + (Secondary Energy Benefit).
 (e) Orange County Sanitation Districts only.
 (f) Net total energy could increase significantly if enhanced landfill gas recovery estimates were proven by field testing and further study.
 (g) Net total energy could increase by about 70,000 KWH/day if dried sludge were marketable from the desert area.



KEY

ENERGY USED

NET ENERGY PRODUCED

NET ELECTRICAL PRODUCTION

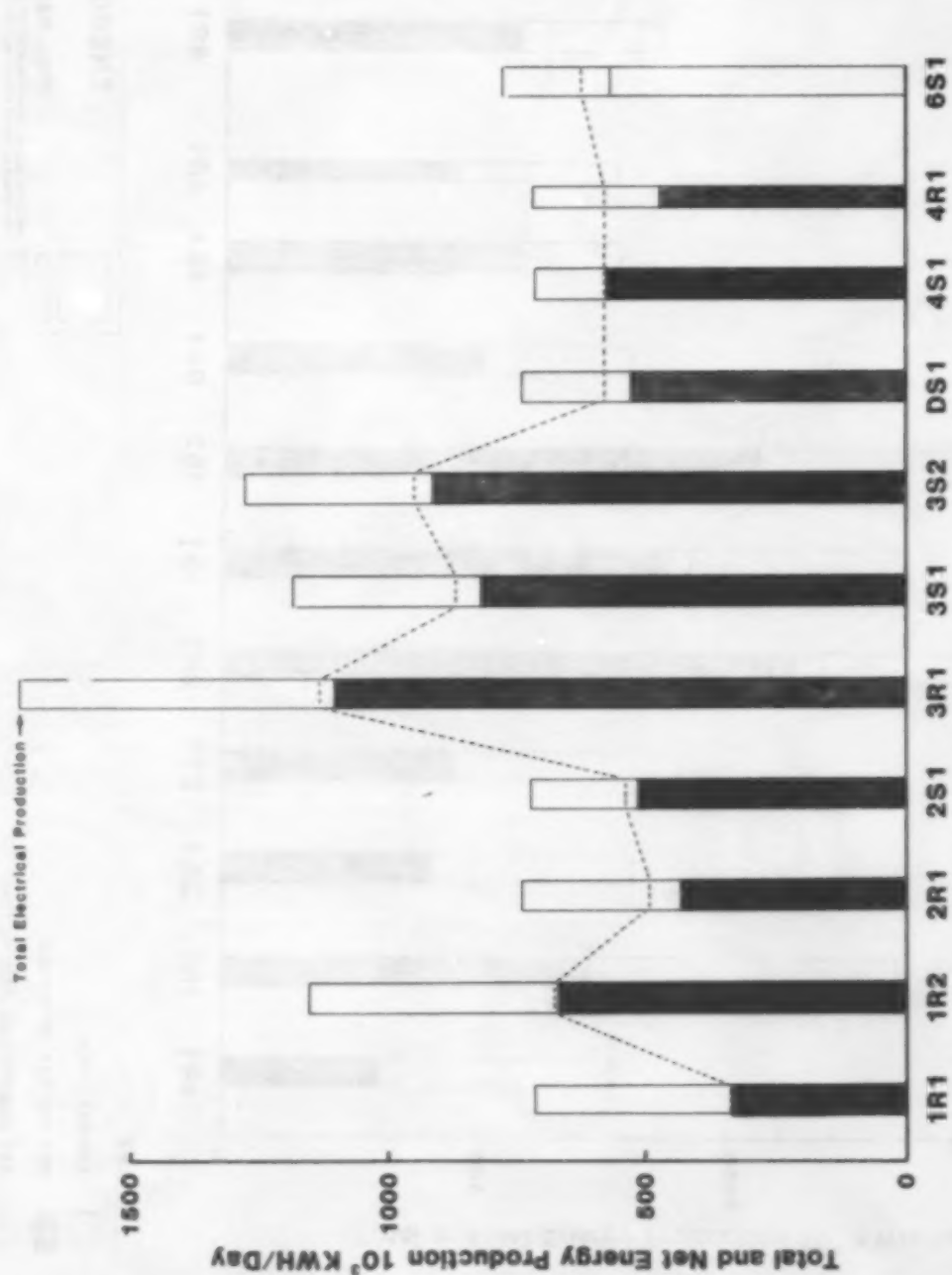
ENERGY PRODUCTION AND USE

FULL SECONDARY TREATMENT

RESEARCH, PLANT MAINTENANCE, RESEARCH, USE AND EXHAUSTION COSTS NOT INCLUDED

FIG. IV-5

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ENERGY PRODUCTION AND USE
PARTIAL SECONDARY TREATMENT
FIG. IV-6

About 500,000 to 600,000 KWH/day of net electricity would be available from the digester gas alone. With addition of thermal processing, net electricity production can be increased by about 50 percent or more depending on the project. For Project 1R2, Desert Energy Recovery, the increase would only be about 25 percent due to the energy requirement for sludge pumping.

There is no major use of other conventional fuels except for the case of diesel oil in barging. Use of polymer organics for dewatering could account for an electrical energy equivalent of about 20,000 KWH/day, while diesel fuel use in trucks accounts for another 10,000 KWH/day. More extensive trucking in the landfilling (DSI) and refuse co-disposal (3S2) projects increases diesel fuel use to an equivalent of about 30,000 KWH/day. The energy equivalent of isopar used in Project 3S1 is about 45,000 KWH/day. Barge Disposal (4R1) would consume a much higher amount of diesel fuel, an electrical energy equivalent of about 100,00 to 400,000 KWH/day, depending on the haul distance. About the same trend in energy production and use was observed for both full and partial secondary treatment scenarios.

Various secondary or indirect energy values can be described in sludge or sludge based materials. For example, use of organic nitrogen in sludge might be considered as a replacement for anhydrous ammonia use and an energy savings would result since the ammonia would not have to be produced. The electrical equivalent of nitrogen and phosphorus nutrients contained in compost was estimated to be about 70,000 KWH/day and 57,000 KWH/day for full and partial secondary treatment on a regional basis. This is about 12 percent of the net electrical production for Project 2S1. The only secondary energy value found to be significant was the possible enhanced generation of landfill gas. However, questions related to technical aspects for recovery and economics of recovery processes need to be answered.

Major conclusions of the energy analysis are summarized below.

1. All of the Sludge Management Projects are net producers of energy in excess of energy requirements for sludge processing and disposal. Digester gas accounts for a major portion of the energy production and is common to all Projects. Differences in net energy between projects results largely from differences in energy consumption and whether digested solids are thermally processed or not.
2. Under conditions assumed in this analysis, the largest net direct energy producers are Energy Recovery from Sludge and Dairy Waste (3R1), Energy Recovery from Sludge and Solid Waste with Refuse (3S2), Energy Recovery from Sludge (3S1), and Desert Energy Recover (1R2). The range of net direct energy production for these projects is from about 740,000 to 1,120,000 KWH/day.

3. If Carver-Greenfield drying is not used for the composting projects, essentially equivalent net direct energy production is realized from the composting projects (2R1, 2S1), Truck Dewatered Cake to Landfill (DS1), Deep Ocean Outfalls (4S1), and Baseline (6S1). Net direct energy production is estimated to be about 550,000 KWH/day from these projects on a regional basis.
4. Carver-Greenfield drying and thermal processing of sludge alone (3S1) can increase net energy production to about 858,000 KWH/day on a regional basis including energy produced from digester gas. Copyrolysis of dewatered cake with an autogenous refuse blend (3S2) will give a net production of about 1,063,000 KWH/day. Using the same quantity of refuse with a Carver-Greenfield dried sludge would increase net direct energy production to about 1,500,000 KWH/day.
5. Secondary energy benefits can potentially be realized from landfill disposal of dewatered sludge cake and expected increases in landfill gas production. Based on estimates presented in Ref. 1, Project DS1 could rank as the highest energy producing system if preliminary estimates of enhanced landfill gas production are realized. Other secondary energy benefits, such as the equivalent energy value of nutrients contained in sludge, are relatively minor, amounting to about 10 percent of the energy value of digester gas.
6. The level of secondary treatment appears to have only a minor effect on net direct energy production. In going from full to partial secondary treatment, the change in net direct energy for all Projects ranges from about a 14 percent decrease in energy to a 13 percent increase (Project 4R1-Off Bight not included).
7. Project 1R2, Desert Energy Recovery, is indicated to produce about 35% more net energy than non-thermal projects conducted individually within the wastewater treatment plants. Project 3S1, Energy Recovery from Sludge, is indicated to result in about 55% more net energy than in-plant non-thermal projects. Project 3S2 (Energy Recovery from Sludge and Solid Waste) can produce energy in proportion to the amount of refuse burned and amount of moisture in the sludge. A ratio of about 1.2 refuse (wet)/sludge (dry) is required to maintain a furnace temperature of 1400°F (definition of the autogenous condition).

AIR EMISSION ANALYSIS

The air emission analysis was divided into three separate areas of investigation: (1) the assessment of direct and net mass emission rates for the five primary pollutants; (2) estimation of toxicant emissions from thermal processing and evaluation of resulting health effects; (3) estimation of maximum ground level concentrations of the five primary pollutants and comparison with ambient air standards. Each of these areas will be discussed in order.

The development of air emission factors for total suspended particulates (TSP), nitrous oxides (NO_x), sulfur oxides (SO_x), hydrocarbons (HC), and carbon monoxide (CO) is discussed in Chapter VII. The air emission factors used in the analysis of the five primary pollutants represent the culmination of over two years of development. Sources of information included literature reviews, actual field and laboratory testing, communications with manufacturers, review and analysis by private consultants, and reviews by air regulatory agencies including the SCAQMD, California ARB, and EPA Enforcement Division, and review by SCAG as the regional air quality maintenance planning agency. Considerable evolution of the factors resulted from the numerous reviews and the development of better information. In the case of thermal processing, it was necessary to conduct source testing on a similar feed sludge to develop factors for NO_x and SO_x .

In all cases, the air emission factors are believed to be reasonably attainable with good engineering and operating practice. This does not imply that lower emission factors are not attainable. For example, there is good evidence to suggest that lower particulate emissions from thermal processing are attainable. Depending on size distribution and other characteristics of the particulates, reduced filter loading and/or electrostatic augmentation can reportedly improve removal efficiency. Capital cost for the baghouse would be increased as a result of reduced filter loading. Thus, there is really no lowest achievable emission factor, but rather a tradeoff between the lower emissions and higher capital and operating costs. The same is true for other factors as well and those used in the analysis are believed to be representative of reasonable and cost effective air emission controls.

Air emission factors used in the analysis are expressed as lb/mmBtu of fuel consumed, except for the case of thermal processing. Each unit process in the treatment train was analyzed to determine the daily fuel consumption. The latter was then multiplied by the appropriate emission factor to give the mass emission rate of the pollutant. In the case of thermal processing, mass and energy balances were performed around the thermal reactor to determine the flue gas volume and mass. These were then multiplied by the appropriate emission factors to give the mass emission rate.

In some cases, opportunities exist to further reduce direct air emissions through application of innovative control measures. Whether any particular measure is cost and energy effective, will depend largely on results of this air emission analysis, the relative magnitude of reduction offered by the added control measure, and the ability to meet new source review requirements.

Key assumptions used in the air emission analysis are outlined as follows:

- Direct project emissions represent the sum total of emissions from all unit operations in the treatment train including processing, transportation, ultimate disposal and utilization of produced digester gas.

- Emissions resulting from combustion of landfill gas are not included in the analysis.
- Emission offsets are calculated based on net electrical power production and correspond to a steam electric utility using fuel oil.
- A portion of digester gas is combusted in a boiler to produce steam for digester heating. All remaining digester gas is used in a combined cycle power facility.
- A portion of steam produced from thermal processing is used to supply heat demands for sludge dehydration.
- No H_2S is removed from digester gas prior to combustion.
- Applicable emission factors are those shown in Table VII-5.

A considerable quantity of data were generated as part of the air emission analysis. This information is difficult to summarize because of the differing viewpoints toward air emissions. On the one hand, there is the question of net environmental impact on the air basin; on the other is the question of compliance with regulatory requirements such as new source review. Having a net beneficial impact on an air basin does not guarantee compliance with regulatory requirements. For further information, the reader is directed to the discussion in Chapter VII.

Direct emissions for regional projects are presented in Table IV-3 and for in-plant projects in Tables IV-4 to IV-6. Emissions for in-plant projects are also presented graphically in Figures IV-7 to IV-9.

As a measure of air quality impact, the projects were compared according to the sum of particulate, NO_x , SO_x and hydrocarbon emissions. The rationale for direct summation of these pollutants came from analysis of the State and National ambient air quality standards. Considering the longest exposure times available for each pollutant, the ambient standards are very similar for each of the five pollutants except CO. The latter is greater by a factor of about 100. Considering particulate, SO_x , and NO_x , the National Primary Standards are 75, 80, and 100 ug/m^3 on an annual average basis. The hydrocarbon standard is 160 ug/m^3 for a 3 hour exposure but would probably reduce to the above range for longer duration exposure. While a gram of one pollutant is not equal to a gram of another, the ambient air standards do suggest a measure of equivalence between particulate, SO_x , NO_x , and hydrocarbons with CO being considerably less significant. The national ambient air standards were based primarily on health related impacts of the pollutants and, therefore, the suggested equivalence must be understood in terms of this impact. The pollutants might have vastly differing impacts in other areas, for example, visibility.

TABLE IV-3
AIR POLLUTANT MASS EMISSIONS RATES
FULL SECONDARY TREATMENT
REGIONAL PROJECTS

PROJECTS ^(a)	AIR POLLUTANT EMISSIONS				
	NOx	SOx	TSP	CO	HC
1R1	lb/Day				
S. Edwards	39	6	5	37	6
TOTAL	2816	2008	155	1037	256
1R2					
S. Edwards	5490	1901	591	165	95
TOTAL	8267	3903	741	1214	352
2R1					
Fontana	1210	212	66	820	130
TOTAL	3456	2167	222	1824	383
3R1					
Chino	8387	2896	865	250	140
TOTAL	11,160	3900	1020	1433	425
4R1					
Bight	1160	182	127	1536	242
TOTAL	4244	2236	311	2920	553

(a) The in-plant emissions for the projects are approximately the same as the emissions for Project 4S1 given in Table in Table IV-3 to IV-5.

TABLE IV-4
AIR POLLUTANT MASS EMISSION RATES
FULL SECONDARY TREATMENT
CLA

	AIR POLLUTANT EMISSIONS				
	NOx	SOx	TSP	CO	HC
<u>Direct Emissions</u>					
2S1	900	540	51	343	85
3S1	2550	1102	221	393	113
3S2	3335	2170	587	620	185
DS1 ^(b)	1080	570	69	559	118
4S1	871	522	48	310	78
6S1 ^(b)	10,835	543	296	1493	4422
<u>Net Emissions^(a)</u>					
2S1	589	173	(3)	316	61
3S1	1906	341	108	337	63
3S2	2512	1198	443	548	121
DS1 ^(b)	683	101	0	524	87
4S1	469	47	(22)	275	47
6S1	10,666	209	251	1493	4394
<u>1978 Base Operation</u>					
	4701	217	124	594	1932

(a) Direct Emissions less electrical offsets.

(b) Includes only direct project emissions and excludes any emissions from enhanced landfill gas production.

(c) Values in parentheses indicate the amount by which electrical offsets are greater than direct emissions.

TABLE IV-5
AIR POLLUTANT MASS EMISSION RATES
FULL SECONDARY TREATMENT
LACSD

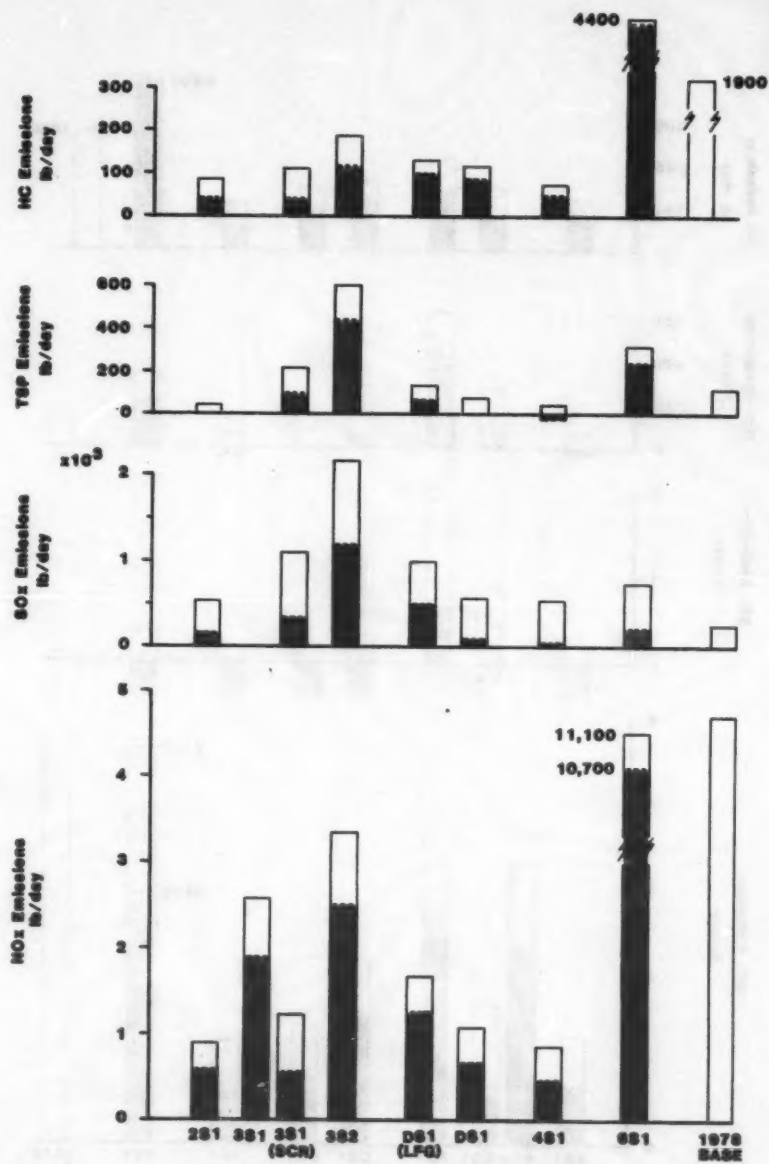
	AIR POLLUTANT EMISSIONS			CO	HC
	NOx	SOx	TSP		
<u>Direct Emissions</u>	lb/Day				
2S1	1240	220	69	483	118
3S1	3212	904	271	534	151
3S2	3770	1940	634	743	221
DS1 ^(b)	1375	238	84	664	147
4S1	1212	213	66	438	110
6S1	8613	260	274	1380	3372
<u>Net Emissions^(a)</u>					
2S1	682	(439)	(28)	434	74
3S1	2274	(204)	107	452	78
3S2	2701	677	447	650	137
DS1 ^(b)	762	(486)	(23)	610	99
4S1	593	(518)	(42)	384	62
6S1	8442	(442)	214	1393	3332
<u>1978 Base Operation</u>	4764	89	131	603	1934

- (a) Direct emissions less electrical offsets.
- (b) Includes only direct project emissions and excludes any emissions from enhanced landfill gas production.
- (c) Values in parentheses indicate the amount by which electrical offsets are greater than direct emissions.

TABLE IV-6
AIR POLLUTANT MASS EMISSION RATES
FULL SECONDARY TREATMENT
OCSD

	AIR POLLUTANT EMISSIONS				
	NOx	SOx	TSP	CO	HC
<u>Direct Emissions</u>	lb/Day				
2S1	750	1340	42	283	69
3S1	2074	1745	180	315	90
3S2	2710	2660	477	495	149
DS1 ^(b)	825	1350	50	376	83
4S1	710	1272	39	253	63
6S1 ^(b)	9014	1324	244	1202	3686
<u>Net Emissions^(a)</u>					
2S1	488	1042	(2)	261	49
3S1	1550	1126	88	269	49
3S2	2040	1869	360	436	97
DS1 ^(b)	502	969	(6)	348	58
4S1	385	888	(18)	225	38
6S1 ^(b)	8867	1322	207	1201	3663
<u>1978 Base Operations</u>	4116	660	200	521	1681

- (a) Direct emissions less electrical offsets.
 (b) Includes only direct project emissions and excludes any emissions from enhanced landfill gas production.
 (c) Values in parentheses indicate the amount by which electrical offsets are greater than direct emissions.



KEY

■ Project Emissions with Offsets

□ Offsets from Electrical Power Production

□ Full Secondary Treatment

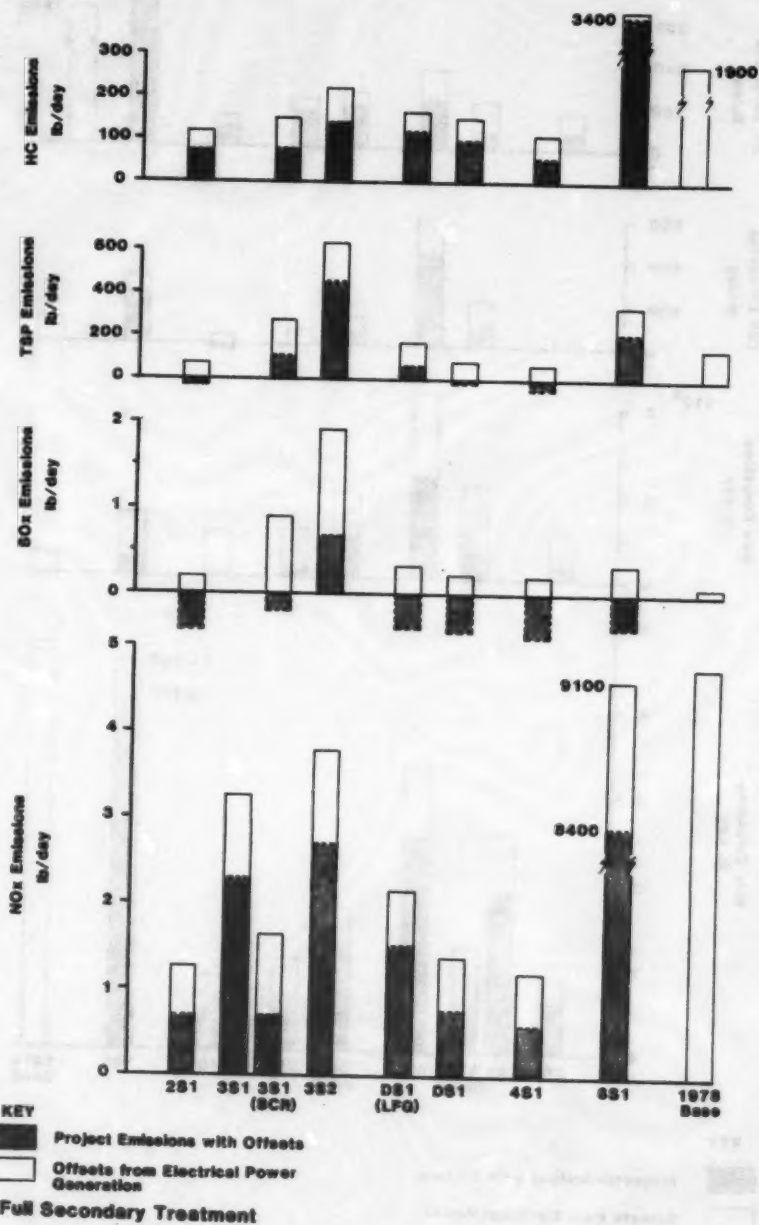
AIR EMISSIONS OF PROJECTS

CITY OF LOS ANGELES

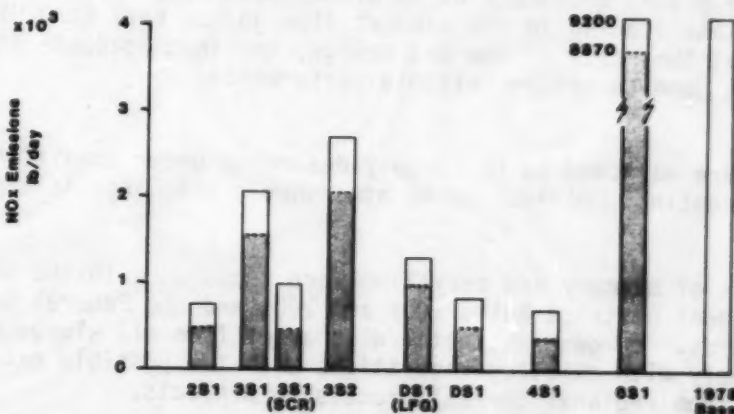
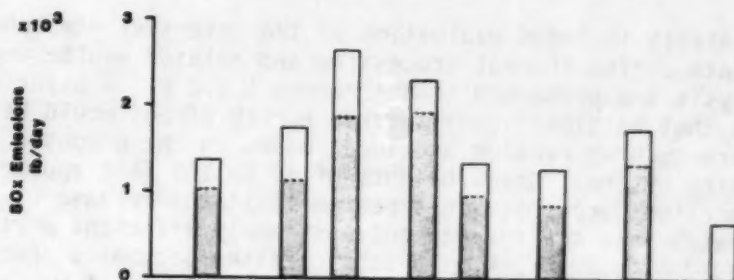
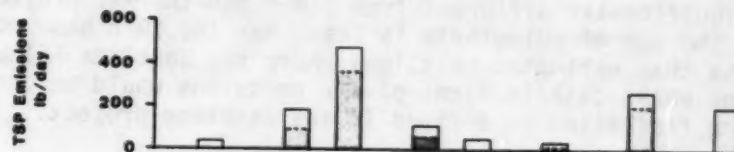
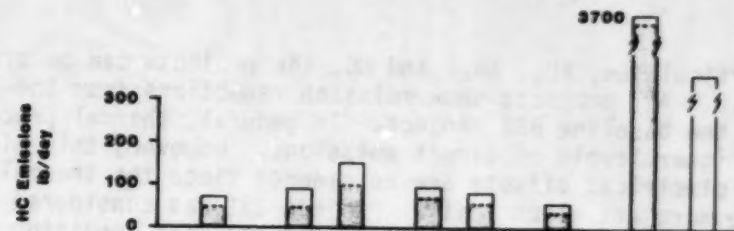
REGIONAL SLUDGE MANAGEMENT PROGRAM

LOS ANGELES/FRANCO COUNTY METROPOLITAN AREA

FIG. IV-7



AIR EMISSIONS OF PROJECTS
LOS ANGELES COUNTY SANITATION DISTRICTS
 REGIONAL SLUDGE MANAGEMENT PROGRAM
 LOS ANGELES-ORANGE COUNTY METROPOLITAN AREA
FIG. IV-8



KEY

- Project Emissions with Offsets
- Offsets from Electrical Power Generation
- Full Secondary Treatment

AIR EMISSIONS OF PROJECTS

ORANGE COUNTY SANITATION DISTRICTS

REGIONAL SOLID WASTE MANAGEMENT PROGRAM
LOS ANGELES/ORANGE COUNTY METROPOLITAN AREA

FIG. IV-9

Using the sum of particulates, NO_x , SO_x , and HC, the projects can be arranged as shown in Figure IV-10. All projects show emission reductions from the 1978 base conditions and from the baseline 6S1 project. In general, thermal processing projects result in higher levels of direct emissions. However, this picture changes somewhat if electrical offsets are considered since the thermal processing projects produce more net electricity. Project 3S1 was considered with two levels of NO_x reduction on the thermal process; (1) the base condition with 50 percent reduction (3S1), and (2) use of selective catalytic reduction (SCR) to achieve a 90 percent reduction (3S1 SCR). Under the latter conditions, net air emissions are not significantly different from other non-thermal projects. In all cases, however, the sum of pollutants is less than the 1978 base condition and considerably less than estimated emissions under the Baseline 6S1 alternative. This implies that the worst case in terms of air emissions would be continued operation of existing facilities as defined in the Baseline project.

The air emission analysis included evaluation of the potential atmospheric discharge of toxicants during thermal processing and related health impacts. Details of the analysis are presented in References 1 and 6. A major conclusion of the analysis was that no significant adverse health effect would be expected for metals of concern such as cadmium and lead, based on the proposed design of the thermal processing system. Stack heights of 50 to 150 feet appeared to be acceptable for dispersion purposes. In order to limit the release of toxicant containing particulates into the environment, extremely efficient particulate control devices should be used, such as a fabric filter baghouse. Particular attention should be given to capture of submicron particles. It was recommended that total particulate loading in the exhaust flue gas be kept at 0.01 gr/ACF or lower, preferably at the state of the art design, and that adequate air monitoring and sampling be done to assure reliable performance.

Organic toxicants are expected to be largely destroyed under conditions achieved during thermal processing. Minimal or no atmospheric discharge is expected.

Potential emissions of mercury and beryllium were compared with the South Coast Air Quality Management District Rules 1003 and 1004 and the Federal New Source Performance Standards. In general, metal discharges from all sludge management projects would comply with existing regulations with the possible exception of mercury emissions from regional thermal processing projects.

Maximum 1-hour ground level concentrations for the five primary pollutants were calculated using procedures described in Reference 1. Stack heights of 100 feet for the thermal processing facility and 50 feet for the combined cycle plant were assumed. Maximum ground level concentrations were then compared with the most stringent limits of either the California or Federal ambient air standards for in-plant facilities. At the respective wastewater treatment plants, all alternative projects with the exception of the Baseline No-Project Alternative (6S1) were projected to result in lower ground level concentrations of oxides of nitrogen (NO_x) and hydrocarbons (HC) than the 1978 Base Case. Particulates (TSP) and carbon monoxide (CO) were projected to remain at essentially the same levels

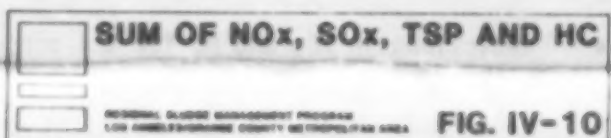
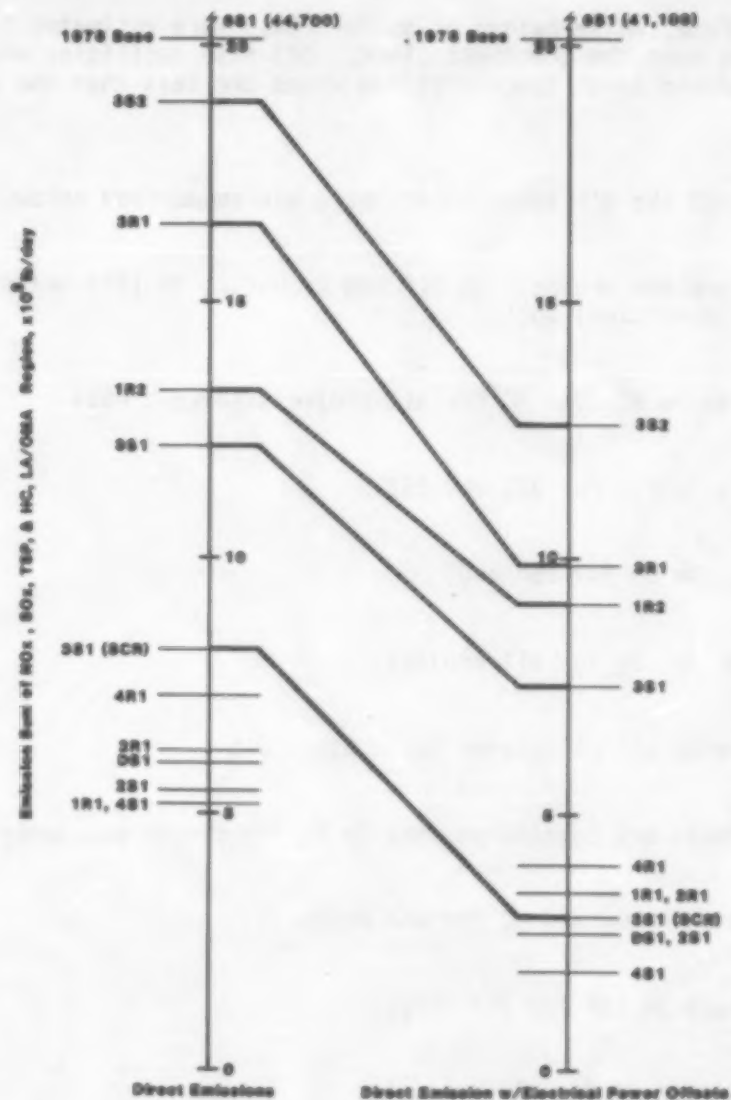


FIG. IV-10

as the 1978 Base Case, while oxides of sulfur (SO_x) were estimated to increase slightly depending upon the treatment plant. Off-site facilities would result in additions to ground level concentrations which are less than the ambient air standards.

Major conclusions of the air emission analysis are summarized below.

1. Considering in-plant projects at CLA and comparing to 1978 emission levels, the following conditions apply:

- Reductions in NO_x and HC for all projects (except 6S1).
- Increases in TSP for 3S1 and 3S2.
- Increases in CO for 3S2 and
- Increases in SO_x for all projects.
- Increases in all pollutants for project 6S1.

If electrical offsets are considered, the following conditions apply:

- Reductions in NO_x and HC for all projects.
- An increase in TSP for 3S2 only.
- Reductions in CO for all projects.
- Increases in SO_x for 3S1 and 3S2.
- Increases in all pollutants except SO_x for project 6S1.

2. Considering in-plant projects at LACSD and comparing to 1978 emission levels, the following conditions apply:

- Reductions in NO_x and HC for all projects (except 6S1).

- Increases in TSP for 3S1 and 3S2.
- Increases in CO for 3S2 and DS1.
- Increases in SO_x for all projects.
- Increases in all pollutants for project 6S1.

If electrical offsets are considered, the following conditions apply:

- Reductions in NO_x and HC for all projects (except 6S1).
- Increase in TSP for 3S2 only.
- Increases in CO for 3S2 and DS1.
- Increase in SO_x for 3S2 only.
- Increases in all pollutants except SO_x for project 6S1.

3. Considering in-plant projects at OCSD and comparing to 1978 emission levels, the following conditions apply:

- Reductions in NO_x and HC for all projects (except 6S1).
- An increase in TSP for 3S2 only.
- Reductions in CO for all projects (except 6S1).
- Increases in SO_x for all projects.
- Increases in all pollutants for project 6S1.

If electrical offsets are considered, the following conditions apply:

- Reductions in NO_x and HC for all projects (except 6S1).
 - An increase in TSP for 3S2 only.
 - Reductions in CO for all projects (except 6S1).
 - Increases in SO_x for all projects.
 - Increases in all pollutants for project 6S1.
4. For Projects 3R1 and 1R2, emissions from thermal processing would occur at a different site, and in the case of 1R2 in a different air basin, from the combustion of digester gas. Improved digester gas combustion is a major source of potential air emission tradeoffs. If the latter tradeoffs are not applied, thermal processing at outlying sites would result in increased emissions of all five primary pollutants. TSP, SO_x and NO_x emissions would exceed limits for new source review. Application of net electrical tradeoffs produced at the offsite facility would not entirely offset the emission increases. Requirements for "prevention of significant deterioration" have not been considered in this analysis.
 5. Comparing the projects on a regional basis and considering the sum of NO_x , SO_x , HC, and TSP pollutants, all projects show emission reductions from the 1978 base condition and from the baseline 6S1 project. Thermal processing projects result in higher levels of direct emissions. However, nearly equivalent emission levels result if electrical offsets are considered and if advanced NO_x reduction technology is used during thermal processing.
 6. Significant adverse health related impacts are not expected from atmospheric discharge of heavy metals such as cadmium, lead, and zinc, during thermal processing.
 7. Expected increases in ground level concentrations are less than the increment of the most stringent ambient air standards in all cases except the baseline Project (6S1). For in-plant emissions, ground level concentrations should be less than or equivalent to 1978 base conditions, except for SO_x for which an increase is projected.
 8. The above analysis is contingent upon cleanup or replacement of existing, digester gas fueled, IC engines, the major source of present emissions. A combined cycle power system for conversion of digester gas to electrical power was assumed in this analysis.

9. In many cases, additional opportunities are available to further reduce direct emissions through application of innovative control technologies.
10. In-plant projects were examined for compliance with new source review (NSR) requirements as defined in Regulation XIII of the South Coast Air Quality Management District. 1978 base emissions were compared with direct project emissions. Electrical offsets were used for tradeoff purposes (offset factor = 1.2) when necessary. H₂S removal from digester gas (80 percent removal efficiency) was assumed in determining direct project emissions.

2S1, 3S1, 4S1, DS1 3S2	Compliance with NSR is projected. NSR requirements exceeded for TSP emissions for all three agencies, and also for SO _x emissions for LACSD and CLA. Offsite tradeoffs required.
6S1	NSR requirements exceeded for NO _x and HC emissions for all three agencies. Off-site trade-off required.
11. In-basin regional projects were examined for compliance with new source review under the same conditions as described in 10 above, with the following exceptions. An offset factor of 2.0 was assumed, which is equivalent to a distance of 50 miles between the source and the trade-off. Only offsets from JWPCP and CLA were assumed to be eligible for Projects 2R1 and 3R1 due to basin wind patterns.

2R1	Compliance with NSR is projected.
3R1	NSR requirements exceeded for NO _x , SO _x and TSP emissions. Inadequate in-plant trade-offs available; additional off-site trade-offs required.
4R1	Compliance with NSR is projected.
12. Out-of-basin regional projects were examined for compliance with new source review under the same conditions as described in 10 above, with the following exceptions. In-plant trade-offs were not considered eligible emission offsets for the regional facilities. The South East Desert Air Basin (SEDAB) was assumed to be a non-attainment area for TSP and oxidants and their precursors (i.e NO_x, HC and SO_x) and requirements for prevention of significant deterioration (PSD) were assumed to apply. An offset factor of 1.2 was assumed at both in-basin and out-of-basin facilities.

1R1

Compliance with NSR requirements is projected at both in-basin and out-of-basin facilities. Some air quality modelling and monitoring may still be needed to show compliance with PSD requirements.

1R2

Compliance with NSR requirements is projected at in-basin facilities. NSR requirements exceeded for TSP and its precursor SO_x at the out-of-basin facility. Extensive air quality modelling and monitoring is expected to be required to determine compliance with PSD requirements.

RANK ORDERING OF PROJECTS

The major quantitative information developed during this analysis included economics, energy consumption and production, and air emissions. For purposes of rank ordering, energy factors were assumed to be represented by economics. This was felt to be a reasonable approach since both costs and credits for energy consumption or production were included in the economic analysis. Furthermore, the effect of future energy price increases was considered in the inflation analysis. Thus, two rank orderings were developed as a result of the quantitative analysis, one for economics (including energy) and one for air emissions.

ECONOMICS AND ENERGY

In order to rank the projects one must decide which economic factors to use as the basis for ranking. Current annual costs reflect only present costs and represent a short-term economic view. The interim plus base present worth represents a long-term economic viewpoint, since it includes effects of inflation, implementation delay, and differing service lives over a 47-year period. In addition to these, inflation has been determined to be a particularly significant sensitivity which could be considered as part of an economic assessment.

Rather than select one economic factor as the basis of project ranking, various combinations of factors were considered. Weights applied to each economic factor are shown in Table IV-7. Under the "Balanced View" approach, an equal weight was applied to short term economics and the combination of long term economics plus the inflation sensitivity. The latter was represented by year 20 annual costs with 12 percent inflation for energy and chemicals and 8 percent for labor and maintenance. The interim plus base present worth also included an across the board 8 percent inflation rate. To avoid excessive double accounting of inflation, long term economics were given a higher weighting. Short term economics were split evenly between net current annual costs and the agency share of same.

TABLE IV-7
COMBINATIONS OF ECONOMIC FACTORS
CONSIDERED FOR PROJECT RANKING

	BALANCED VIEW	LONG-TERM ECONOMIC VIEW	OPERATING COST VIEW
<u>SHORT TERM</u>			
Net Current Annual Cost	25	0	0
Agency Share	25	0	50
<u>LONG TERM</u>			
Interim + Base Present Worth	35	100	0
<u>SENSITIVITY</u>			
Year 20 Annual Cost With 12% Energy Inflation	15	0	50

Under the "Long Term Economic View" all weight was given to long term economics. This was felt to represent one extreme viewpoint. Another is represented by the "Operating Cost View" where all weight is placed on operating costs. In this case, the weight was split evenly between agency share of current annual costs and year 20 annual costs. The latter includes some capital amortization but it is largely insignificant compared to operating costs in year 20.

All projects were quantitatively ranked relative to the baseline project for each economic factor shown in Table IV-7. For purposes of this ranking, the baseline project was assigned a value of 1.00. Weights shown in Table IV-7 were applied to each economic factor and projects ranked according to their total score. Results of the analysis are presented in Table IV-8. A rather surprising result of the analysis is that project rankings are only affected to a minor extent by the economic view which one selects. Projects at the bottom of the ranking remain at the bottom. Likewise projects ranked at the top, remain at the top regardless of the economic viewpoint. No projects jump from low to high rankings by changing the economic viewpoint.

Since project ranking is not sensitive to the economic view, it seemed reasonable to select the balanced view as most representative of a wide range of economic interests. A summary of quantitative rankings according to the balanced view is shown in Table IV-9. In one case, projects are ranked relative to the baseline which is assigned an arbitrary value of 1.00. In the second case a relative scale is established with the least cost alternative assigned a value of 100, and the highest cost alternative a value of 0. All other values are proportioned between these limits.

Numerical values can be used to assess the relative cost differences between projects. The Deep Ocean Outfall Project (4S1) is the least cost alternative followed closely by the landfill disposal project with enhanced gas recovery DS1 (2). Note that landfill disposal (DS1) is the most costly alternative if enhanced landfill gas is not realized for any reason. The desert projects (1R1 and 1R2) are about mid-range in cost. In-plant projects (2S1, 3S1, and 3S2) are nearly equivalent in cost and occupy the upper range of values. The total cost range from the least to the most expensive alternative is approximately a factor of 2.

AIR EMISSIONS

Air emissions from the Projects presented some difficulties in ranking. Five major air pollutants were considered in the analysis, namely particulates (TSP), nitrous oxide compounds (NO_x), sulfur oxide compounds (SO_x), hydrocarbons (HC), and carbon monoxide (CO). Different projects emit different amounts of each pollutant making a direct comparison somewhat difficult. The projects could be ranked for each pollutant but the five resultant rankings would be difficult to interpret. To overcome this difficulty and to provide a more straightforward

TABLE IV-8
RANKING OF PROJECTS ACCORDING TO (a)
VARIOUS ECONOMIC VIEWPOINTS

BALANCED VIEW	LONG-TERM ECONOMIC VIEW	OPERATING COST VIEW
4S1	4S1	1R2
DS1(2)	4R1	DS1(2)
4R1	DS1(2)	4S1
6S1	6S1	1R1
1R2	1R2	4R1
1R1	1R1	6S1
2R1	2R1	3R1
2S1	2S1	3S2
3S1	3S1	3S1
3R1	DS1	2R1
3S2	3R1	2S1
DS1	3S2	DS1

(a) Project 2S1X applies only to OCSD and was ranked only according to "Balanced View" economics. In this case, 2S1X ranked between Projects 2S1 and 3S1.

TABLE IV-9

SUMMARY OF QUANTITATIVE PROJECT RANKINGS
ACCORDING TO BALANCED VIEW ECONOMICS

BALANCED VIEW	RANK TO BASELINE	RELATIVE SCALE
4S1	0.65	100
DS1(2)	0.81	80
4R1	0.95	64
6S1	1.00	57
1R2	1.06	50
1R1	1.19	34
2R1	1.29	22
2S1	1.35	15
3S1	1.35	15
3R1	1.36	13
3S2	1.42	6
DS1	1.47	0

approach, the projects were ranked according to the sum of particulate, NO_x , SO_x , and hydrocarbon emissions. The rationale for direct summation of these pollutants was discussed previously in this chapter.

Using the sum of particulates, NO_x , SO_x , and HC, the project rankings shown in Table IV-10 result. Rankings are presented for both direct emissions and net emissions (direct emissions less offsets for net electrical power production). For the case of direct emissions, the non-thermal processing projects are reasonably equivalent and result in the least direct emissions. Project 3S1 and 3S2 would result in about 2 to 3 times the direct emissions of the non-thermal projects. In all cases, however, direct emissions are considerably less than those projected for the Baseline 6S1 project under year 2000 sludge loads and are also less than estimated 1978 emissions from the treatment plants. Thus, all projects should result in improvements in existing air quality.

A special case of project 3S1 was examined in which catalytic NO_x reduction was applied to the direct fired thermal process. Assuming 90 percent NO_x removal by the catalytic process, direct emissions would be reduced significantly. Project 3S1 would then be higher by a factor of only about 1.6 compared to ocean disposal 4S1 and only about 1.4 compared to landfill disposal DS1.

A somewhat different picture of air emissions results if electrical offsets are considered. Since the thermal processing projects produce more net electricity, the offset is greater than for non-thermal projects. Project 3S1 (SCR) with additional NO_x reduction becomes nearly equivalent to non-thermal projects such as ocean disposal, composting, and landfill disposal, and is lower in net emissions than regional projects such as desert solar drying. Even without additional NO_x reduction, Project 3S1 is lowest in net emissions of all thermal processing projects.

Whether to consider electrical offsets in the air emissions analysis is subject of some debate. Electrical offsets used in Table IV-10 are applied to net electricity production using emission factors presently applicable to Southern California steam generating utilities burning low sulfur (0.25%) fuel oil. This assumes that added electrical loads are met by local generation using fuel oil as opposed to natural gas or importation of hydroelectric power. This appears reasonable since hydroelectric power is limited and of fixed amount and natural gas supplies were sharply curtailed at least until recently. If sludge projects were implemented today, the electrical offsets would likely be realized and the net impact would then be as shown. However, regulating agencies are attempting to reduce emission levels from electrical utilities. For example AQMD rules may require NO_x reductions from existing levels in the future. Thus, the amount of electrical offset may decrease in future years. The actual air impacts would then lie somewhere between the two rankings shown in Table IV-10.

TABLE IV-10

PROJECT RANKINGS FOR AIR EMISSIONS
REGIONAL BASIS

DIRECT EMISSIONS		NET EMISSIONS	
SUM ^(a)	RANK	SUM(a)	RANK
5200	4S1	1930	4S1
5240	1R1	2700	2S1
5420	2S1 ^(c)	2750	DS1
5990	DS1	3490	3S1(SCR) ^(b)
6230	2R1	3450	1R1
7340	4R1	3490	2R1
8260	3S1(SCR) ^(b)	4040	4R1
12210	3S1	7480	3S1
13260	1R2	9090	1R2
16510	3R1	9900	3R1
18840	3S2	12600	3S2
44690	6S1	41130	6S1

1978 Estimated emissions for particulates, NOx, SOx and HC sum to 20,550 lb/day on a regional basis.

- (a) Sum of particulates, NOx, SOx, and HC emissions on a regional basis.
 (b) Selective catalytic NOx reduction (SRC) used to achieve 90 percent NOx reduction during thermal processing.
 (c) Project 2S1X would rank just below Project DS1 considering only OCSD emissions.

ENGINEERING PRACTICALITY

The engineering practicability of the alternatives was assessed in terms of the following:

- Feasibility, including construction effort and skilled manpower requirements.
- Flexibility, including ability to expand and responsiveness to operational failures, regulatory standards, and changes in wasteloads.
- Reliability, including effects of natural disasters, operational and equipment complexity, redundancy, prior application, and social factors such as strikes and disruptions.
- Occupational, including job related noise, safety, and health.

The factors and components of the engineering evaluation are summarized in Table IV-11. Each of these components were evaluated for each project element: final disposition, final transportation, off-site processing, interim transportation, and on site processing. Also, an evaluation for the overall project was conducted.

Table IV-12 presents criteria used for evaluation of the projects. Successful application in the field of municipal wastewater treatment, ease of adaptability, and low level of sophistication were traits which characterized good engineering practicability. The converse of these traits was judged to result in lower practicability. Lack of prior application in the LA/OMA area of a practice accepted in other parts of the United States and a degree of sophistication associated with the conventional activated sludge wastewater treatment sources were judged to be neutral as was a finding of some difficulty in adaptability to changing conditions. In this case, it was recognized that achieving adaptability might require redesign.

TABLE IV-11

ENGINEERING FACTORS AND COMPONENTS ENGINEERING PRACTICALITY

FACTOR	COMPONENT	DESCRIPTION
Feasibility ⁽¹⁾	• Construction	Degree of effort involved in constructing the facility, including shop drawing preparation and review, actual construction, and qualified contractors and start-up.
	• Skilled Manpower	Level of required operator education and training. Availability of such manpower.
Flexibility ⁽²⁾	• Expansion	Ability with available technology to add or delete unit processes to expand capacity of established unit processes in gradual increments without affecting redundancy.
	• New Technology	Ability to respond to foreseeable new technology as well as the probability of it happening.
	• Operations	Ability of downstream unit processes to cope with upstream operational or equipment failures without an impact on quality and quantity of the final product or method of ultimate disposal and without changes in the process flow diagrams as presently defined.
	• Regulatory Standards	Ability to respond to foreseeable, new environmental quality standards (e.g., water quality, air quality, public health, resource recycling and conservation).
Reliability ⁽⁴⁾	• Wasteload Changes	Ability to respond to changing estimated populations and wasteloads (e.g., sewage solids or refuse) without expansion.
	• Natural Disasters	Effect of seismic events, floods, and power outages.
	• Operational and Equipment Complexity	Level of process complexity affecting reliability when run by a trained operator. Level of equipment reliability and complexity. Degree of automation and sequential process steps.
	• Redundancy	Degree of backup equipment of similar kind. ⁽⁵⁾
	• Prior Application	Degree of prior application in the wastewater treatment field. Application in unrelated industrial fields. No prior full scale application.
Occupational	• Social Factors	Effect of employee strikes. Impact from disruption of supplies by strikes, outside energy, or supply demands.
	• Noise	Only considered within treatment or construction site boundaries. Includes speech interference and hearing loss; excludes perceived noise by local population. ⁽³⁾
	• Safety	Only considered within treatment or construction site boundaries. Includes job related injuries; excludes safety of local population.
	• Health	Includes job related illnesses inside plant boundary.

(1) Capable of being done or carried out; capable of being used or dealt with successfully.

(2) Capable of responding or conforming to a changing or new situation.

(3) Perceived odors and noise by the general public will be considered in the Environmental Evaluation.

(4) Suitable or fit to be relied upon; dependable.

(5) Ability of downstream unit processes to cope with operational or equipment failures is considered under the Flexibility Factor.

TABLE IV-12
EVALUATION CRITERIA

CATEGORY	CRITERIA
A Excellent	Long-term use in municipal wastewater treatment with good repeatable success; easily adaptable; degree of sophistication associated with primary treatment.
B Good	Applied in municipal wastewater treatment with mostly successful results; moderately adaptable; degree of sophistication associated with advanced primary treatment.
C Neutral	Limited use in LA/OMA area but accepted practice in other areas of U.S. with good repeatable success; adaptable with some difficulty; degree of sophistication associated with the conventional activated sludge process.
D Fair	Limited utilization in municipal wastewater treatment with questionable adaptability; degree of sophistication associated with advanced wastewater treatment processes.
E Poor	Not utilized in municipal wastewater treatment or limited application with many demonstrable results; minimal adaptability; degree of sophistication associated with highly mechanized industrial processes.

RESULTS OF THE ANALYSIS

A summary of the overall project ratings for each component is presented in Table IV-13. This table allows comparison of each project. However, it should be remembered that the rating system is qualitative/judgmental in nature and that letter designations represent a range, rather than a single point.

Results of the project evaluation are summarized below. From the standpoint of engineering practicability, there were no significant differences among the three wastewater treatment complexes (i.e., Hyperion, JWPCP, and OCSD). Thus, the treatment plants were evaluated collectively and a single conclusion drawn for each alternative. It should also be noted that while varying levels of engineering practicability are indicated, all alternative projects are judged to be practicable.

Decentralized Dewatering and Composting (2S1): The significant engineering and operational factor for this alternative would be the dehydration process. This would be a complex process to construct and would require above average skilled manpower for operation. The dehydration process has been successfully operating in the food processing industry and has been employed in Japan for processing municipal waste. However, a full scale dehydration process has not been operated in the United States on combined primary and waste activated sludges from municipal wastewater treatment. The alternative also would involve mechanical composting which is in a similar state of development. Since the dehydration process would handle only a portion of the sludge volume (i.e., enough to assure a uniform 30 percent feed solids to the mechanical composting system), some concern for continual satisfactory performance may be relieved.

Deletion of the dehydration process from the unit flow train would alleviate concerns associated with such processes but also reduce the ability of the mechanical composting system to withstand substantial variation in dewatered sludge solids content. Since the alternative would involve mechanical dewatering and truck transportation, there might be some reduced ability to freely operate such systems during labor disputes. Care would be required to protect against effects of occupational exposure to sludge that has not been composted.

Round Canyon Composting/Air Drying (2S1-X): The significant engineering and operational factor would be the ability of the system to operate during wet weather conditions, and to consistently achieve a 50 percent solids material required for landfill disposal. To alleviate wet weather problems, an operational pattern was described in which air drying and stockpiling of a portion of the dried sludge would occur during dry months. Dry material would be used during wet months as a conditioning agent and blended with dewatered cake prior to aerobic composting. Wet cake storage, mechanical metering and mixing facilities, hard surfacing of the compost area, coverage of the compost area, a forced

TABLE IV-13
SUMMARY OF OVERALL PROJECT RATINGS
Qualitative Engineering Evaluation

	FEASIBILITY			FLEXIBILITY			RELIABILITY			OCCUPATIONAL (OPERATION)			OCCUPATIONAL (CONSTRUCTION)		
	Construction	Skilled Manpower	Expansion	New Technology	Operations	Regulatory Standards	Waste Load Changes	Natural Disasters	Operation & Equip. Comp.	Prior Application	Redundancy	Social Factors	Health	Safety	Noise
2S1	D	E		B											
3S1	D	E													
3S2	D	D													
DS1	D	B	B	B											
4S1	D	B	B	B	A	E	B		A	B	B	B	B	B	B
1R2	D	B	B		B	B	B	E	D	D	B	B	D		
2R1	D	D	B					E	D	D			D		
3R1	D	E						E	E	E			D		
4R1	E	E			B	D	E	E	E	E			D		
Baseline															
6S1	B	B	B	B	B	E	B		B	B	B	B	D	B	B

NOTE: Neutrals are shown as blank to highlight differences among alternatives.

A - Excellent
B - Good
D - Fair
E - Poor
BLANK - Neutral

aeration system, and achieving the maximum practicable cake solids from dewatering were also been identified as measures to alleviate wet weather operational problems. All of these measures would be feasible and practical from an engineering standpoint. The alternative was considered average in terms of construction requirements, skilled manpower needs, and operation and equipment complexity. Since the alternative would involve mechanical dewatering and truck transport, there may be some reduced ability to fully operate the system during labor disputes. Care would need to be taken to protect against effects of occupational exposure to sludge that has not been composted. The alternative has good expansion potential provided sufficient buffer lands are included in the original site acquisition.

Energy Recovery From Sludge (3S1): The combination of dehydration, thermal processing, and energy recovery systems, and air emission controls would result in greater overall effort for construction and would require skilled manpower for operation. Concerns would exist regarding the ability of thermal processing systems to respond to failures in upstream processes and to respond to increasingly stringent air emission requirements. Other concerns as discussed under Decentralized Dewatering and Composting (2S1) relative to the dehydration system would also apply here and would be compounded by addition of the thermal processing system. During an air pollution episode, the thermal processing system may be required to halt or reduce operations. There may be reduced ability to continue full operations during labor disputes.

Energy Recovery From Sludge and Solid Waste (3S2): This alternative would include solid waste processing to produce a refuse derived fuel for combination with dewatered sludge in a thermal processing system. Operational concerns relative to failures in upstream sludge processing systems and air quality concerns would be similar to those for Energy Recovery From Sludge (3S1). Concerns for complexity and prior application would be alleviated by substitution of the processed refuse to achieve autogenous combustion. However, inclusion of refuse processing would add concerns regarding ability to operate the system during disruptions in refuse collection services arising from labor disputes since it would be impractical to store large quantities of unprocessed refuse. Additionally, refuse processing would involve potentially high noise levels and exposure of workers to refuse. Operation of the thermal processing system in a pyrolysis mode has had limited application in municipal wastewater treatment.

Truck Dewatered Sludge to Landfills (DS1): This alternative would be relatively uncomplex from the standpoint of engineering practicability. Concerns would exist, however, regarding the ability to respond to increasingly stringent limits on water content of dewatered sludges and disruptions associated with labor disputes. Potential worker exposure to dewatered sludge would also be of concern. There would be reduced ability to operate dewatering and trucking systems during labor disputes. Advantages, however, would include operational simplicity, low reliance on skilled manpower, and ease of expansion.

Deep Ocean Outfalls (4S1): From the standpoint of engineering practicability, this alternative would be characterized by low equipment complexity and minimal requirements for skilled manpower. The alternative could easily cope with upstream process changes and offers good response to increases in wasteloads. Operation should involve minimal concern with occupational health since there would be minimal exposure. A significant engineering consideration for this alternative would be construction of new ocean outfall systems to depths of about 1,000 feet, depths which are considered to be near the present state of the art. At this time, the alternative would not conform to federal and state water quality requirements. Labor disputes should have minimal effect on operations.

Solar Drying (1R1): A problem associated with all the regional alternatives would be the vulnerability of the pipeline to earthquakes. The pipeline also would require a substantial construction effort. An advantage of this alternative would be its low reliance on skilled employees and its simplicity of operation. The alternative would have good expansion potential because of probable land availability.

Desert Energy Recovery from Sludge (1R2): This alternative would have the earthquake, construction, and health concerns of Solar Drying Basins (1R1), plus operational considerations including the thermal processing system with its sophisticated emission control devices and power generation system. The alternative would have good expansion potential because of probable land availability.

Centralized Dewatering and Composting (2R1): The earthquake and construction concerns associated with other regional projects would be present. The alternative would involve low level health risks to employees, require an average skill level, and would have good expansion potential.

Energy Recovery from Sludge and Dairy Waste (3R1): This is a regional alternative that would combine dehydrated sludge with dairy waste in a thermal processing system. Concerns would include potential for earthquake damage to the pipeline, skilled manpower requirements, a high degree of construction effort, air emission standards and pollution episodes, employee exposure to dairy waste, complexity of the dehydration and thermal processing systems, and the fact that dehydrated sludge and dairy waste have not been combined in a thermal processing system.

Barge Disposal (4R1): The significant engineering/operational consideration for this alternative would be the barge transportation of sludge. The alternative would be considered average in terms of construction requirements, skilled

manpower needs, and operation and equipment complexity. The system would be susceptible to strikes by barge operating personnel. At this time, the alternative would not conform to federal and state water quality requirements.

Baseline No-Project (6S1): This alternative would have the advantages of low complexity of operations, prior application, and ease of construction. Ocean disposal does not conform to federal and state water quality requirements. Potential disruptions arising from labor disputes could be alleviated by the outfall systems. There may be worker exposure to uncomposted sludge.

RANK ORDERING OF PROJECTS

Under engineering practicality the projects were divided into four groups, Group I having the highest relative practicality and Group IV the least. Factors taken into consideration while grouping the projects were feasibility, flexibility, reliability and occupational considerations. Under each group again, the position of any particular project indicates its relative practicality.

Group I alternatives had the general characteristics of high feasibility, high adaptability, ease of construction, operation and maintenance and usually had some prior application and experience associated with them. Group II alternatives exhibited these characteristics to a lesser extent, but with generally successful prior applications. Group III alternatives had more limited prior application or were more difficult to adapt, construct, operate, or maintain. Group IV alternatives the least feasible, least adaptable, most difficult to construct, operate and maintain, or had little or no prior application. Any single project may not exhibit all the characteristics of a particular group and decisions based on engineering judgment and experience were necessary in many cases.

Group I

Four of the twelve alternative were placed in this group. Shared traits would include moderate to low complexity and moderate to high reliability afforded by ocean disposal. Landfill disposal of dewatered sludge, while generally low in complexity, would not share the flexibility and reliability provided by ocean disposal, particularly during wet weather periods.

6S1 Low complexity, high flexibility, extensive prior application, low skilled manpower. Existing outfall provides added flexibility and reliability.

- 4R1 Moderate complexity, moderate skilled manpower requirements. Possible labor problems because of operational intensiveness.
- 4S1 Low complexity, high flexibility, low skilled manpower. Not susceptible to labor problems but requires construction of deep outfall at state of the art level.
- DS1 Much the same as 6S1 but does not share the flexibility and reliability provided by an ocean outfall. More trucking than 6S1.

Group II

Four of the alternatives, characterized by a degree of complexity associated with air drying and composting, were included in this group.

- 1R1 Combination of solar drying and pipeline was considered less complex and more reliable than composting and dehydration.
- 2S1 Slightly more complex and less reliable than 1R1 due to dehydration and mechanical composting.
- 2S1X Windrow composting should be operationally less complex than mechanical composting, but is more susceptible to disruptions during wet weather. Incorporation of air drying provides for reduced susceptibility to wet weather disruptions compared to conventional windrow composting.
- 2R1 Slightly less reliable than 2S1 because of the added effect of windrow composting during wet weather operation.

Group III

The three alternatives included in this group are characterized by significantly increased mechanical complexity due to inclusion of thermal processing and dehydration.

- 1R2 Significantly increased mechanical complexity compared to projects in Groups I and II due primarily to thermal processing. Considered the least complex of Group III projects since it involves only thermal processing of solar dried sludge.

3S1 Added mechanical complexity over 1R2 due to added mechanical complexity of the dehydration process. Mechanical dewatering is probably equivalent to solar drying and pipeline.

3S2 Operational considerations are associated with RDF processing, dependency on refuse for successful operation, and possible disruptions due to labor problems in refuse industry. Other factors similar to 3S1.

Group IV

Only one alternative, Energy Recovery From Sludge and Dairy Wastes, (3R1) was placed in this group. Principal reasons for such placement center around a general lack of large scale experience involving energy recovery from manure by thermal processing. Added to this concern was a requirement for dehydration of the municipal sludge to assure autogenous combustion.

IMPLEMENTATION POTENTIAL

The potential for implementation of a project is an important consideration in program selection. A technically good alternative is of little value if it cannot be implemented. To provide for systematic analysis of this complex subject, consideration of implementation potential has been divided into the factors of regulatory compatibility, public acceptability, and practicality. Each of these factors has been further identified by the components defined in Table IV-14. The alternative sludge management projects were evaluated in terms of these components.

Evaluation criteria, representing broad continuums of significance, were established as part of the development of the comparative evaluation process. Criteria for evaluation of the components of implementation potential are listed in Table IV-15. These criteria are based upon the assumption that the implementability of a project will be affected by public attitudes in support of or opposition to the project. To be implemented, a project must comply with established laws and regulations and have a good measure of consistency with other related activities. This is not to exclude the possibility for changing laws and regulations and related activities, but as the criteria show, the need for such actions are believed to reduce implementation potential. In addition, the implementation strategy would need to provide a means of managing sludge in compliance with established laws and regulations while a change is being pursued. Elapsed time is a measure of implementation potential since it may affect the ability to comply with laws and regulations and can affect the economic standing of alternatives.

It is important to note that final determination of regulatory compatibility rests with the respective regulatory agencies. The evaluation has not attempted to estimate the probability for securing regulatory approvals since such actions would be the subject of great deliberation and involve factors beyond the scope of the evaluation.

Conclusions regarding acceptability are based upon evidence obtained by the LA/OMA Project Public Participation Program. This program involved community and neighborhood meetings and documentation of impact that was received. While conclusions are believed reflective of general attitudes, such conclusions are not based upon statistical sampling. Additionally, data for the evaluation was obtained during the period July through November, 1978. Passage of time may alter public attitudes.

TABLE IV-14

IMPLEMENTATION FACTORS AND COMPONENTS

FACTOR	COMPONENT	DESCRIPTION
Compatibility	Water Resources	Consistency with laws and regulations pertaining to water use, water quality, and water pollution. Principal topics of concern are discharge of sludge to the ocean, protection of ground water quality, and compliance with water quality control requirements.
	Air Resources	Consistency with laws and regulations pertaining to air quality including air quality management planning. Principal focus of concern are new source review requirements, prevention of significant deterioration and standards at the federal and local level, and air quality management planning.
	Land Resources	Consistency with laws and regulations pertaining to land use and protection of ecological resources. Concern centers around permits for use of land, provisions for protection of rare and endangered species and coastal zone management.
	Waste Management	Consistency with laws and regulations pertaining to solid waste management and land application of sewage sludge. Principal focus is solid waste permits and potential EPA regulations regarding reuse of sludge.
Acceptability	Neighborhood - A	Persons living within 1/4 mile of a processing or disposal location.
	Neighborhood - B	Persons living within 1/2 mile of a processing or disposal location other than the wastewater treatment plants.
	Community	Persons living more than 1/2 mile from a processing or disposal site.
	Public Officials	Persons holding public office.
	Interest Groups	Persons with a particular identifiable interest in a sludge management project.
	Interested Public Agencies	Public agencies not holding permitting authority.
Practicality	Institutional	Availability of agencies and authorities to carry out the project.
	Time	Total elapsed time for pre-design studies; design of facilities; acquisition of lands; and construction of facilities.

TABLE IV-15
CRITERIA FOR EVALUATION OF IMPLEMENTATION POTENTIAL

EVALUATION CATEGORY	CRITERIA
A Excellent	High degree of acceptability; judged with a high degree of certainty to be compatible with applicable laws and related planning; minimal time for implementation (terminates all sludge discharge to the ocean by the end of 1981).
B Good	Moderate degree of acceptability; legal or planning compatibility dependent upon policy interpretation (waivers and exemptions not included); moderate amount of time required for implementation (5 years or less).
C Neutral	Indeterminate acceptability; any incompatibility believed resolvable through further study during pre-design; intermediate amount of time required for implementation (5-10 years).
D Fair	Low degree of acceptance; formal administrative action to establish regulations, or grant waiver or exemption or to change regulations is necessary to assure legal or planning compatibility; substantial amount of time required for implementation. (10-15 years)
E Poor	Strong opposition. Legislative or judicial action required to change law or interpretation thereof is necessary to assure legal or planning compatibility; excessive amount of time required for implementation (more than 15 years).

RESULTS OF THE ANALYSIS

A summary of the results of the evaluation of regulatory compatibility, public acceptability, and practicality is given in Table IV-16. Neutral ratings are not shown to highlight differences between projects.

Principal areas of concern with respect to water resources were discharge of sludge to the ocean, protection of groundwater quality and control of runoff. With respect to air quality, principal areas of concern were preconstruction (new source) review of major new or modified stationary air pollutant emission sources, requirements related to prevention of significant deterioration of ambient air quality in clean air areas, and mass emission standards for certain contaminants. Principal regulatory concerns related to land and land based ecological resources appeared to center around permits for use of land, provisions for protection of rare and endangered species and coastal zone management. Of principal interest to waste management facilities, were regulations pertaining to land application of sludge, and solid waste management efforts related to resource recovery.

Public participation efforts met with varying degrees of success. A lack of participation resulted in indeterminate acceptability levels for neighbors of the proposed Fontana and Round Canyon sites, the OCSD Joint Works and affected existing and proposed landfill sites.

With the exception of the Desert and Orange County, community input was also insufficient to determine acceptability. With respect to the Desert community, all alternatives which would not bring sludge to the Desert area would have a good degree of acceptance while alternatives involving the desert would have a fair to poor acceptance level. Orange County community input indicated a good to excellent degree of acceptance for regional projects which would transport sludge to a centralized land based facility for processing and disposal.

Nuisance potential and protection of human health were most important to the public contacts. Resource recovery (compost or energy) was generally supported provided risks were minimal. Achievement of improved sludge characteristics through industrial source control and public education to reduce use of undesirable substances was also supported.

In general, practicality of regional alternatives was considered to be fair since such alternatives would require establishment of new institutions with authority to plan, design and construct regional sludge management facilities. A new agreement among the three operating agencies would appear to be needed before design of recommended facilities could be started. Additionally, it may be desirable to incorporate other agencies or parties to such agreement to facilitate acceptance to an alternative. On the other hand, individual projects could generally be conducted within the existing authorities of the local LA/OMA operating agencies.

TABLE IV-16

SUMMARY OF QUALITATIVE EVALUATION
OF IMPLEMENTATION POTENTIAL

	Regulatory Compatibility	Water Resources	Air Resources	Land Resources	Waste Management	Public Acceptance	Neighbors	Hypertion	JWPCP	OCSD Plant #2	Public Officials	Interest Groups	Interested Agencies	Practicality	Institutional	Time
2S1	A	A	A	A*	D**		na	D	D		b	B		A	A	
2S1X	A	A	A	D	A		b	na	na	na	b	B		A	A	B
3S1	A	A	B	A	A		na	D	D	D	b	B		A	A	
3S2	A	A	D	D	B		na	D	D	D	b	B		A	A	
4S1	E	A	A	A	A		na							A	A	
DS1	A	A	A	D	A		ab						D	A	A	
1R1	B	A	A	D			E	A	A	B	D	D	D	A	D	D
1R2	B	B	D	D			E	A	A	B	D	B	D	D	D	D
2R1	B	B	D	D	D**		b	B	B	B	b	B	D	D	D	D
3R1	D	D	D	D	D		b	B	B	B	b	B	D	D	D	D
4R1	E	E	B	A	A		b			D	b			D	D	D
6S1	E	A	A	A	A		na	D	E	D	b		D	D	A	A

na - not applicable
a - landfill neighbors
b - indeterminate

A - Excellent
B - Good

D - Fair
E - Poor

Blank - Neutral

* City of Los Angeles is "Fair" because of concern with the Rare and Endangered Species Act.
** Lack of regulations is the principal reason for conclusion.

NOTE: Neutrals are shown as blank to highlight differences among alternatives.

Development of regional alternatives which involved location of sludge processing or disposal facilities in new areas would likely require more time than individual alternatives. The proposed regional projects involved consolidation of 3 regional agencies serving some 8,000,000 persons into a single entity and potential pipeline lengths of as much as 100 miles. It appears reasonable to conclude that a significant time frame for the LA/OMA regional alternatives of 15 years would not be considered out of the question. Individual projects were judged to require less time for implementation. Based upon local agency experience, it did not seem unreasonable to conclude that 7-10 years would be required for inplant facilities, with the exception of landfills.

As a general conclusion from the standpoint of practicality, individual alternatives would have highest implementation potential. It was also doubtful that implementation of a regional alternative could be easily achieved without active participation by the state and federal levels.

Decentralized Dewatering and Composting (2S1): Except for the City of Los Angeles, principal regulatory concern was lack of EPA regulations governing urban recycling of composted sludge. Landfilling of composted sludge should be feasible if regulations were to be issued which could not be met. In the City of Los Angeles Hyperion Treatment Plant, use of land at the western end of the L.A. International Airport appeared necessary. Such area may be subject to provisions of the Rare and Endangered Species Act. Incorporation of removal of hydrogen sulfide from digester gas should enable achievement of a net emission increase of less than 150 pounds per day for sulfur dioxide. Reductions from current levels in emissions of oxides of nitrogen, and hydrocarbons were projected due to assumed use of all digester gas in combined cycle power generation systems.

Public acceptance levels were related to concern for nuisances and public health.

Experiences with the existing windrow composting/recycling system was a major factor at JWPCP.

Round Canyon Composting/Air Drying (2S1-X): Principal regulatory concern centered around securing a use permit for the facility, control of onsite runoff, and lack of EPA regulations governing urban recycling of composted sludge. Adequate design of runoff control facilities should alleviate concerns with control of such runoff. Composted/air dried sludge at greater than 50 percent solids should be suitable for landfill disposal. Processed sludge could be landfilled until quality conditions are set by EPA regulations. Incorporation of removal of hydrogen sulfide from digester gas should enable achievement of net emission increase of less than 150 lbs./day for SO₂. Reductions from current

levels in emissions of oxides of nitrogen and hydrocarbons were projected due to assumed use of all digester gas in combined cycle power generation systems. Public acceptance was interminate but the potential for concern regarding nuisance potential and health should be kept in mind.

Energy Recovery From Sludge (3S1): Principal regulatory concern appeared to be associated with air quality. Except for LACSD, incorporation of removal of hydrogen sulfide from digester gas and use of state-of-the-art flue gas desulfurization controls should result in net emission increases of sulfur dioxide of less than 150 pounds per day. For LACSD, these measures would appear to fall short (by some 80 pounds per day) of achieving such reductions under the assumptions of the analysis. Interpollutant offsets, emission offset reductions at locations outside the treatment plants, incorporation of emissions into the State Implementation Plan, as provided by AB 524 Calvo, and higher base emission estimates were factors which could result in lower net emission increases. Reductions from current levels were projected for emissions of oxides of nitrogen and hydrocarbons due to assumed use of all digester gas in combined cycle power generation systems. If disposal of ash/char in Class II-1 landfills were precluded, such material could be hauled to Class I landfills.

While the concept of energy recovery was relatively well received, such reaction was predicted upon minimization of air pollutant emissions. Concern was raised by Hyperion neighbors regarding odor potential.

Energy Recovery From Sludge and Solid Waste (3S2): Principal regulatory concern appeared to be associated with air quality. Substantial net emission increases were projected for sulfur dioxide and particulates. While additional controls for sulfur dioxide could be applied as described for Energy Recovery from Sludge (3S1), a significant net emission increase would remain. Similarly, greater particulate control may be feasible, however, the efficiency of such high efficiency control systems on refuse systems was uncertain. There would appear to be greater potential need for waiver of preconstruction review requirements than for Energy Recovery From Sludge (3S1). A use permit would also be required for establishment of a refuse processing station at the treatment plants.

Neighbors of treatment plants indicated a fair acceptability due to opposition to increased truck traffic and views regarding the existence of refuse processing in their neighborhood. Interest groups and interested agencies expressed interest in codisposal of sludge and refuse.

Deep Ocean Outfalls (4S1): Ocean disposal of sludge is prohibited by the California State Ocean Plan. Such discharge, if not precluded, would be governed by the provisions of a National Pollutant Discharge Elimination System (NPDES) Permit. If such permit were to contain effluent limits based upon secondary

treatment, a sludge only discharge would likely be precluded. Additionally, EPA requirements for ocean dumping would need to be met. Most publics commented that since ocean disposal would be effectively precluded by regulatory actions, there was little need to discuss the possibility. Rather, there was a feeling that efforts should be directed to other possibilities. An exception was input from neighborhood and elected officials associated with the City of Los Angeles Hyperion Treatment Plant who submitted continued ocean disposal as an interim solution until uncertainties associated with effects of various alternatives were to be resolved.

Solar Drying Basins (1R1): The location (South Edwards site) and facility design features should be capable of providing for groundwater protection, and control of onsite runoff, and prevention of wash-out. Requirements for a land use permit and compliance with requirements of the Rare and Endangered Species Act were the principal constraints affecting the compatibility with regulatory requirements. Relocation of the alternative to alternate desert sites could reduce concern with rare and endangered species requirements but could increase the concern for issuance of a use permit, as other counties would be involved. Air quality concerns at the treatment plants would be similar to those associated with Decentralized Dewatering and Composting (2S1).

Alternatives involving the desert posed serious acceptability problems. Potential neighbor and community reaction was generally in opposition to the proposed alternative. Such opposition was largely a reaction to the fact that solids would come from the LA/OMA urban area. A group (Citizens Revolt Against Pollution), was formed to oppose the alternative. Concerns were raised regarding potential public health and environmental concerns. A few individuals did express support for serious examination of the proposed alternative by the Desert Community. However, the level of opposition far outweighed such statements public officials submitted in opposition to the alternative.

Desert Energy Project (1R2): In addition to the constraints described for the Solar Drying Basins Project (1R1), this alternative would also be affected by requirements for prevention of significant deterioration of air quality. It could be difficult to demonstrate compliance with these requirements without extensive modelling and ambient air quality modelling. In addition, particulate and SO_x emissions would appear to be subject to new source review requirements. It could be difficult to find sufficient offsets in the desert area. Emissions standards for mercury may also be exceeded by this alternative. Air quality concerns at the individual treatment plants would be similar to those associated with Decentralized Dewatering and Composting (2S1).

Public acceptance levels would be the same as Solar Drying Basins (1R1).

Centralized Dewatering and Composting (2R1): The alternative would involve location of mechanical dewatering and windrow composting facilities in a new area. Requirements for land use permits was the major concern for regulatory compatibility since these facilities may be viewed as incompatible use of land by the governing body of jurisdiction. Lack of EPA regulations governing urban recycling of compost were not considered a major factor since composted sludge may be landfilled. However, lack of such regulations could adversely affect the issuance of a permit.

Failure to recycle sludge could raise concerns about landfill capacity in the Fontana area, however, other landfills in the LA/OMA urban area could be used albeit involving greater transportation distances. Air quality concerns at the treatment plants would be the same as Decentralized Dewatering and Composting (2S1).

Neighborhood acceptability of this alternative was indeterminate. However, potential concerns regarding nuisance and health should be kept in mind. San Bernadino County agencies submitted comments indicating a low level of acceptance.

Energy Recovery From Sludge and Dairy Waste (3R1): Regulatory concerns were noted with regard to groundwater protection, disposal of thermal processing residue, onsite runoff controls, and procurement and management of cooling waters. With respect to air resources, emissions of SO₂, oxides of nitrogen and particulates appeared subject to new source review requirements and require offsets. Emissions of mercury may exceed established emission standards. It was possible that other thermal processing systems or additional emissions controls could overcome air quality problems. However, in view of the need to dehydrate sludge prior to combustion with the dairy manure, there seemed to be little advantage since thermal processing of dehydrated sludge can be conducted at the individual treatment plants under Energy Recovery from Sludge (3S1). A land use permit would also be needed. Air quality concerns at the treatment plants would be the same as Decentralized Dewatering and Composting (2S1).

Neighborhood acceptability was indeterminate, however, potential for concerns with regard to nuisance and health should be kept in mind. San Bernardino County agencies and the Dairy Environmental Council showed interest in the alternative however, final agency response was neutral.

Barge Disposal (4R1): Ocean dumping of sludge is prohibited by the Federal Marine Protection, Research and Sanctuaries Act after 1981. Air quality concerns within the treatment plants were the same as Decentralized Dewatering and Composting (2S1). Emissions reductions appeared achievable within the treatment plants which, if allowed, could offset emissions resulting from barging operations.

Acceptability concerns would be as described for Deep Ocean Outfalls (4S1).

Baseline No-Project Alternative (6S1): Ocean disposal of sludge would be subject to the same regulatory constraints as Deep Ocean Outfalls (4S1). Use of digester gas in internal combustion engines does not appear to require new permits. A similar situation exists with respect to permits related to land resources and waste management.

With the exception of neighbors to the Hyperion treatment plant, there was no support for continuation of the existing situation. Concern was expressed principally with regard to nuisances, air emissions, and truck traffic. Hyperion neighbors indicated support for continued ocean disposal as an interim measure until uncertainty regarding effects of various alternatives was resolved.

RANK ORDERING OF PROJECTS

REGULATORY COMPATIBILITY

Alternative projects are categorized in four groups ranging from highest (Group I) to lowest (Group IV) implementation potential in terms of regulatory compatibility. In summary, emphasis has been placed upon the need for land use permits since avoidance of new or modified use permits should enhance implementation potential. Group I projects appear to have the fewest number of problems. Projects with potential use permit problems involving jurisdictions within the LA/OMA urban area were placed in Group II since there is an indicated causal relationship between these agencies and sludge management needs. Group III projects appear to have substantial land use permit problems involving local governmental jurisdictions outside of the LA/OMA urban area and indicated potential use permit problems involving siting of solid waste management facilities. Group IV projects are common with respect to the low prospects associated with ocean disposal of sludge.

Group I

Rationale

2S1 Decentralized Dewatering
and Composting
(LACSD/OCSD)

Can be conducted entirely within treatment plant boundaries at the Joint Water Pollution Control Plant and OCSD Joint Works. No land use permit modification needed. Composted sludge readily landfilled if recycle not permitted.

3S1 Energy Recovery from
Sludge

Can be conducted solely within treatment plant boundaries at all operating agencies. Compatibility with the use permit requirements should be achievable. Reductions in existing emissions and use of adequate emission control systems and, as necessary emission offsets provided in the State Implementation Plan as authorized by AB 524 Calvo, should enable compatibility with air quality requirements.

Group II

Rationale

DS1 Truck Dewatered Cake
to Landfills

Substantial difficulty expected in obtaining use permits at landfills. Can avoid many concerns related to nuisance and health effects.

1R1 Solar Drying

Problems expected in obtaining use permits at South Edwards site. In view of strong opposition in the Desert area this project would rank at the very bottom of Group II. If a site outside of L. A. County is used, this project would be listed in Group III. Since jurisdictions not directly related to the sludge management problem would be involved in issuing a use permit. The South Edwards site may also be subject to provisions of the Rare and Endangered Species Act.

2S1 Decentralized Dewatering
and Composting (CLA)

Land limitations at Hyperion may require use of land at end of LAX. This land is currently subject to Rare and Endangered Species Act limitation and potential coastal zone management requirements. Rare and Endangered Species Act constraints may be removed pending a California Department of Fish and Game recommendation.

2S1X Round Canyon Project
(OCSD)

A use permit for the Round Canyon facilities would be required. Composted sludge can be readily landfilled if recycle is not permitted.

Group III

Rationale

1R2 Desert Energy Project

This project has all of the land use permit problems described for Project 1R1 and concerns for air emissions in the desert area. Problems may exist regarding compatibility with air quality requirements.

2R1 Centralized Dewatering and Composting

Requirements for a use permit from San Bernardino County may be difficult to meet. Lack of regulations may add to the difficulty.

3R1 Energy from Sludge and Dairy Waste

Potential difficulties with land use permit requirements, new source review requirements and water quality requirements related to ground water and onsite runoff. Since sludge has to be dried prior to mixing with manure, there is no apparent advantage to LA/OMA area. This may increase the likelihood of permit problems.

3S2 Energy from Sludge and Solid Waste

Concerns exist regarding use permits related to solid waste processing at the treatment plant sites. Also, difficulties with new source review requirements are indicated.

Group IV

Rationale

4R1 Barge Disposal

Legislative prohibition.

4S1 Deep Ocean Outfalls

Requires a NPDES permit which would allow discharge of 20,000-50,000 mg/l of suspended solids; currently prohibited by the State Ocean Plan.

6S1 Baseline "No Project" Alternative

An interim program which involves ocean discharge.

PUBLIC ACCEPTABILITY

Alternative projects are categorized into four groups ranging from the more accepted (Group I) to the least accepted (Group IV) in terms of acceptability to the various public groups. In areas of question, input from potential neighbors was considered the more crucial to acceptability of a particular project.

Group I projects were those with more broadly based public support than opposition. Group II projects included those with some support from neighbors and other public groups, with more neutrality and little opposition. Group III projects were characterized by more neutrality and opposition than support, with neighbors tending to be neutral and/or the level of opposition considered as not too great to overcome with additional public contact. Group IV projects were characterized by strong and broadly based opposition, with some neutrality and perhaps even limited support.

Group I

Rationale

None

None of the sludge management projects examined from the public acceptability aspect indicated broadly based public support.

Group II

Rationale

2S1 Decentralized Dewatering
 and Composting

While concerns raised by the neighbors of this project did not indicate "support" (LACSD/CLA), they could be resolved. The project was broadly supported in its ability to recycle a soil conditioner from sludge.

2S1X

This project was rated below Project 2S1 based upon the limited public input. The ability to contain metals in a landfill and to recycle compost after metals content is reduced to an acceptable level were considered positive public acceptance aspects.

3S1 Energy Recovery from
 Sludge

This was the most supported project by neighbors as well as other public groups. CLA neighbors were concerned with potential nuisances and air quality impacts.

DS1 Truck Dewatered Cake
 to Landfills

This project was determined to be in Group II because of its ability to avoid many major concerns expressed by the participating public. Neighbors of landfills were not contacted during the assessment, and therefore, their degree of acceptance was not known. However, it was not expected to be "supportive" of the project.

2R1 Centralized Dewatering
 and Composting

This project is in the "lower portion" of Group II. While support was expressed for its recycling aspect, it would potentially have impacts that would cause concern especially to the neighbor public.

3R1 Energy Recovery from
 Sludge and Dairy Waste

This project is also in the "lower portion" of Group II. The ability to recycle energy from two wastes was considered an important benefit. However, potential impacts of nuisances and degradation of air quality concerned various public groups.

Group III

Rationale

3S2 Energy Recovery from
 Sludge and Solid Waste

This project was largely opposed by neighborhood groups because of the potential for importing solid waste through their residential area. However, support for codisposal and resource recovery was expressed.

4S1 Deep Ocean Outfalls

This project was generally considered as unacceptable based upon its prohibition by state and federal regulations. Little time was spent on its discussion, with the exception of CLA neighbors who supported its continuation until a better project was proposed. Project 4R1 (Barge Disposal) was not discussed with the public. However, a basically similar reaction could be expected.

Group IV

Rationale

1R1 Solar Drying Basins

This project had broad opposition, which was categorized as "strong opposition" in the case of neighborhood acceptance. Support for the project was expressed in the limited potential for recycling a soil conditioner, and especially a solution to remove sludge from the urban environment.

1R2 Desert Energy Project

This project had the same degree of opposition and similar support.

6S1 Baseline - "No Project"

This project was strongly opposed by some neighbor groups. The limited recycling and ocean disposal aspects were not considered favorably among the participating publics, with the exception of the CLA neighbors as previously discussed.

ENVIRONMENTAL ACCEPTABILITY

ENVIRONMENTAL ACCEPTABILITY

The objective of the environmental evaluation was to provide information on the environmental acceptability of the proposed sludge management projects which would serve as input for the comparative analysis process. Only a brief summary of the most pertinent environmental information will be presented here. For more information, the reader is referred to the draft EIS/EIR (Ref. 6).

The assessment of the alternatives to determine their environmental acceptability was focused in accordance with directives provided by the United States Environmental Protection Agency (EPA) and the California State Water Resources Control Board (SWRCB). Since the alternatives were still relatively conceptual in nature, the environmental assessment was somewhat generic in some cases, providing an indication of the type and/or range of potential impacts to be expected rather than specific, documented conclusions. Although the assessment was somewhat generic in some cases, all the alternatives were evaluated to a level of detail sufficient to provide a clear distinction between them, if in fact distinction would exist were they to be implemented. This distinction, or lack thereof, was one of the key factors in the decisions that were made in identifying those alternatives that had the best prospects for inclusion in the Proposed Sludge Management Program.

All aspects of the construction and operational phases of each alternative were evaluated. These included onsite processing, interim transportation, offsite processing, final transportation, and final disposition. The impacts reported are those that were judged to be most relevant to the decision-making process. Impacts that would be essentially the same for all alternatives, short-lived, and relatively insignificant were omitted in accordance with EPA and SWRCB directives and the most recent NEPA/CEQA guidelines.

The criteria used to evaluate the alternatives with respect to potential environmental impact are listed in Table IV-17.

The system used to individually rate each of the proposed projects and the Baseline "No Project" Alternative was based on absolute standards of measurement that were specific to each component. The basic standard used in rating each component was the presence or absence of an impact, not whether the impact constituted the best or worst that would occur in any given situation. The rating system represented a continuum of significance, ranging between significantly beneficial and significantly adverse as shown in Table IV-18.

TABLE IV-17

ENVIRONMENTAL EVALUATION CRITERIA
ASSESSMENT OF ALTERNATIVES

CONSIDERATION	BASIS OF ASSESSMENT
<u>Physical Resources</u>	
• Mineral Deposits	(1) Presence of minable resource, plus logical/regional significance; (2) Size/potential productivity; (3) size area to be developed
• Prime & Potentially Prime Agricultural Soils	(1) Presence, (2) Size/potential productivity, (3) irrigation potential, (4) size area to be developed.
<u>Biotic Resources</u>	
• Terrestrial Biota	(1) Local/regional significance of existing natural communities/species, (2) degree of stress on inhabitant rare/endangered species, (3) degree of potential hazard to migratory birds, (4) size area to be developed.
• Marine Biota	(1) Structure/composition of communities, (2) changes in feeding strategies, (3) physiological alterations, (4) bioaccumulation of organics/heavy metals, (5) responses of California Bight, (6) rare/endangered species.
<u>Cultural Resources</u>	
• Archaeological Sites	Known on potential presence of individual artifacts; work areas; evidence of farming, hunting, or gathering; burials or other funerary remains; and/or structures.
• Historical Sites	Presence of structures, sites, and/or geographic regions as defined by Advisory Council on Historic Preservation.
<u>Community Patterns & Aesthetic Concerns</u>	
• Visual Character	(1) Visibility, (2) duration of view, (3) hypothesized subjective meaning of proposed facilities.
• Nuisances	(1) Intermittent/permanent source of odors, noise, dust and/or insects; (2) type/level of potential annoyance; (3) hypothesized subjective meaning of annoyance and/or source.

(Table VI-17 continued on next page.)

TABLE IV-17 (Cont.)

CONSIDERATION	BASIS OF ASSESSMENT
<u>Public Health</u>	
• Air Pollutants	(1) Known responses of general population & sensitive individuals, (2) State/Federal ambient air quality standards.
• Heavy Metals	(1) Potential for direct ingestion, (2) worst case ingestion scenarios, (3) acceptable daily intake levels.
• Trace Organics	(1) Potential for entry to human foodchain, (2) worst case ingestion scenarios, (3) comparison of intake to dose response models, (4) comparison of projected risks/acceptable risks.
• Pathogens	(1) Potential for ingestion, (2) comparison of intake to dose response models, (3) product quality for pathogen destruction.
<u>Public Services & Facilities</u>	
• Transportation	Potential for aggravating congestion/conflicts on local streets and/or major arterials during peak hours.
• Waste Disposal	Loss in useful capacity of landfill involved.
• Wastewater Treatment	Amount sidestreams requiring treatment compared to average daily flow.
• Water Supply	Amount freshwater required compared to total system demand.
<u>Economics</u>	
• Public Sector	Magnitude investment required compared to total public expenditures.
• Private Sector	Magnitude of cash flow induced by public investment compared to total construction investment.
• Employment	Amount construction/permanent employment as compared to regional totals.

SOURCE: DNJH

TABLE IV-18
ENVIRONMENTAL ACCEPTABILITY
INDIVIDUAL RATING SYSTEM
PROPOSED PROJECTS AND BASELINE NO-PROJECT

IMPACT RANGE	RATING	ENVIRONMENTAL ACCEPTABILITY
Considerable improvement over existing conditions.	A	Excellent
Some improvement over existing conditions.	B	Good
Insignificant improvement or detrimental change; concurrent improvement and detrimental change of approximately the same magnitude and significance.	C	Neutral ⁽¹⁾
Unavoidable ⁽²⁾ adverse change in existing conditions but without serious long-term implications.	D	Fair
Unavoidable adverse change in existing conditions with serious long-term implications.	E	Poor

(1) It should be noted that a C rating (neutral) is a relatively favorable judgment with respect to environmental considerations; for example, few benefits other than economic/employment are typically associated with implementation of a project, particularly if it is physically oriented. The absence of impacts, therefore, would be considered environmentally acceptable.

(2) Adverse changes that will not be mitigated with implementation of a proposed action or with continuation of existing practices mitigated.

TABLE IV-19
SUMMARY OF ENVIRONMENTAL EVALUATIONS OF
ALTERNATIVE SLUDGE MANAGEMENT PROJECTS

ENVIRONMENTAL ACCEPTABILITY		PHYSICAL RESOURCES		MINERAL DEPOSITS		PRIME & POTENTIAL Prim Ag. Soils		BIOTIC RESOURCES		TERRESTRIAL BIOTA		MARINE BIOTA		CULTURAL RESOURCES		ARCHAEOLOGICAL SITES		HISTORICAL SITES		COMMUNITY PATTERNS AND AESTHETIC CONCERNS		VISUAL CHARACTER		PUBLIC HEALTH CONCERNS		AIR POLLUTANTS		HEAVY METALS		TRACE ORGANICS		PATHOGENS		PUBLIC SERVICES AND FACILITIES		TRANSPORTATION SYSTEM		WASTE DISPOSAL SYSTEMS		WASTEWATER TREATMENT SYSTEMS		WATER SUPPLY SYSTEMS		ECONOMICS		PUBLIC SECTOR		PRIVATE SECTOR		EMPLOYMENT																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
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RESULTS OF THE ANALYSIS

Overall individual project ratings are shown in Table IV-19. Neutral "C" ratings are not shown in order to highlight differences. It should be noted that the environmental acceptability ratings shown in Table IV-19 assume inclusion of all mitigation measures that were considered practicable during the comparative evaluation. In terms of environmental acceptability, therefore, the ratings shown in the table essentially represent those impacts, both beneficial and adverse, that would be unavoidable with implementation of the alternatives. However, this does not necessarily imply that no additional measures could be included to further lessen the severity of remaining adverse impacts.

In terms of the environmental considerations included in the Alternatives Assessment, there appeared to be few distinct advantages with respect to either the individual alternatives or the regional alternatives as a group. Private economic gains and increased employment opportunities would apply equally to all of the alternatives, with only slightly more benefit predicted in desert areas. The only major beneficial impact that was identified would be associated with one of the individual, in-basin alternatives - Energy Recovery From Sludge and Solid Waste (3S2). Implementation of this alternative would essentially result in an increase in landfill capacity because a significant amount of refuse would be burned rather than landfilled. Although not without associated adverse impacts, the energy recovery/thermal processing alternatives (3S1, 3S2, 1R2, and 3R1) would result in the total destruction of trace organics.

With respect to adverse impacts, none of the alternatives would be innocuous. Although the type, number and significance of the adverse impacts would vary, problems of some kind would occur with implementation of any of the alternatives. However, most of the significant, essentially unavoidable adverse impacts that were identified involved three of the four regional alternatives. Major visual conflicts, stress to rare and endangered species, and hazards to migratory birds were anticipated with both of the desert alternatives - Solar Drying Basins (1R1) and the Desert Energy Project (1R2). Excessive demands on the existing water supply system were anticipated with implementation of Energy Recovery From Sludge and Dairy Waste (3R1) at the Fontana site. The only individual, in-basin alternative that would cause significant adverse impacts was the Baseline No-Project (6S1). Implementation of this alternative would entail fairly high potential public health risks with respect to air pollutants and trace organics.

Given the above, the major conclusion reached with respect to the environmental acceptability of the alternatives was that there appeared to be no overriding benefits derived from implementing any of the regional alternatives, including the avoidance of adverse impacts predicted to occur within the basin. Although adverse impacts of non-regional alternatives would not be insignificant, such impacts appeared to be generally avoidable (either through selection of alternatives from among non-regional options or application of mitigation measures) and/or were not projected to be of sufficient magnitude to provide sufficient basis for selection of regional alternatives. In addition, as indicated in the

assessment of quantitative characteristics, energy recovery would be relatively high with all of the in-basin alternatives, while recycling of the sludge would occur with the composting alternatives.

The major findings associated with each alternative are summarized below, followed by a grouping of the alternatives in terms of their overall environmental acceptability. The discussions and rankings assume inclusion of all practicable mitigation measures.*

In general, impacts that were essentially the same and common to all of the alternatives did not provide a basis for determining environmental acceptability. These included costs to the public sector of the economy, induced private economic benefits, and increased employment opportunities. While there would be some differences with respect to these significant issues, they were not of sufficient regional magnitude to provide distinction between the alternatives. Environmental concerns for which insignificant or minimal impacts were anticipated also did not provide a basis for decision. These included mineral deposits, Prime and Potentially Prime Agricultural soils, historical sites, and wastewater treatment systems. Therefore, the environmental acceptability of the alternatives was determined principally with respect to terrestrial and marine biotic resources**, archaeological resources, visual character and potential nuisance problems, public health, transportation, waste disposal, and water supply.

Decentralized Dewatering and Composting (2S1): Although the El Segundo Blue butterfly is present on the CLA-LAX composting site, restricting development to the northern portions would probably protect the species from direct adverse impacts. However, dust, runoff, etc. during construction and operation could represent potential indirect stresses, which would probably require assessment by the federal Endangered Species Committee. Archaeological resources potentially present at the CLA-LAX site could be protected by implementation of an appropriately designed cultural resources mitigation program. Moderate visual conflicts would be experienced at Hyperion, the LAX site, and OCSD No. 1. Moderate to low visual conflicts would occur at JWPCP. Odors and dust could be potential problems at all sites. Heavy metals would be of concern with respect to public health if compost were used for an extended period of time to grow food chain crops. Disposal of composted sludge would reduce the capacity of the Lopez Canyon landfill by a fairly high percentage.

* Although not discussed in the following because it pertains to all alternatives except 2S1-X, archaeological resources potentially present in the JWPCP future expansion area will be protected by implementation of an appropriately designed cultural resources mitigation program.

** It should be noted that ocean disposal is prohibited by existing legislation and that few definitive conclusions could be reached without extensive additional research of deep ocean options.

Round Canyon Composting/Air Drying (2S1-X): Implementation of this alternative would reduce the available foraging area for two pairs of Golden eagles nesting in the Cleveland National Forest by approximately 50 acres. Although this was not considered a sizeable reduction in itself, cumulative impacts resulting from continued development throughout the general area could be significant. Archaeological resources present at the site could be protected by implementation of an appropriately designed cultural resources mitigation program. Although no visual conflicts were anticipated with the existing land uses in the vicinity, major problems could occur in the future if surrounding vacant land were developed for residential uses. Potential problems from odors, dust, and noise also would be minor at present but significant in the future if current development plans for the area are implemented. Containment of sludge in a landfill should reduce concerns with respect to heavy metals and trace organics.

Energy Recovery From Sludge (3S1): The major problems associated with this alternative would be moderate visual conflicts at Hyperion and OCSD No. 1, moderate to low visual conflicts at JWPCP, and some potential for odors and noise at all of the sites involved. Potential public health problems resulting from air pollutants would be greater than for the non-thermal processing alternatives. Assuming stringent particulate controls, only minimal health hazards would be associated with heavy metal emissions. Complete destruction of trace organics would occur during thermal processing.

Energy Recovery From Sludge and Solid Wastes (3S2): While visual conflicts and public health risks would be similar to 3S1, there would be somewhat more potential for problems with odors and noise. Nuisances could also include dust and insects because of the refuse that would be involved.

Deep Ocean Outfalls (4S1): Data are generally unavailable to precisely define impacts upon midwater biotic species. Lack of experience with such practices in the Southern California Bight precludes extension of conclusions derived from other operations. It should be noted, however, that this alternative would accomplish sludge disposal below the thermocline and the more productive upper ocean waters. In addition, significant historical and possibly prehistorical archaeological resources could be adversely affected during construction of the pipeline for this alternative.

Truck Dewatered Sludge to Landfill (DS1): Some potential problems with odors, noise, and dust could be experienced with implementation of this alternative, although experience with existing operations indicates that they would not be overly significant. Containment of sludge in a landfill should minimize exposure to heavy metals and trace organics. Existing congestion and vehicular conflicts on major arterials and local streets could be aggravated, while disposal of dewatered sludge would cause a fairly significant reduction in landfill capacity at Lopez Canyon.

Solar Drying Basins (1R1): Implementation of this alternative could constitute a significant threat to the Mojave ground squirrel population inhabiting the South Edwards site and probably the Mojave City alternate site. The facilities would also represent a significant hazard to migratory birds at all of the desert regional sites. Archaeological resources expected to be present at all of the sites could be protected by implementation of an appropriately designed cultural mitigation program. Significant visual conflicts and potential problems with odors would also be expected particularly with respect to visitors to the Phacelia Wildflower Sanctuary and residents of Hi Vista. There would also be some concerns for health with respect to heavy metals if the dried material, which could be recycled after two years storage, were used for an extended period of time to grow food chain crops.

Desert Energy Project (1R2): Hazards to migratory birds, visual conflicts, and nuisances would be somewhat more significant with this alternative than with 1R1, principally because of the thermal processing building. Effects on sensitive biotic species and protection of archaeological resources would be similar to 1R1. Although potential health concerns associated with air pollutants would be greater than with 1R1, ground level increments would be significantly less than ambient air quality standards. Similar to 3S1 and 3S2, potential public health hazards associated with heavy metals would be minimal with use of stringent particulate controls; trace organics would also be destroyed.

Centralized Dewatering and Composting (2R1): While there would be a potential for visual conflicts and nuisances with implementation of this alternative, they would probably not be overly apparent because of the industrial character of the area. However, there would be some concern for public health with respect to heavy metals if compost were used for an extended period of time to grow food chain crops. Well over half of the capacity of the Millikin landfill would be required for disposal of the composted material. In addition, freshwater requirements would represent a fairly high percentage of the total supplied by the local system.

Energy Recovery From Sludge and Dairy Wastes (3R1): Similar to 2R1, minor aesthetic problems would probably be experienced with implementation of this alternative. Potential public health problems resulting from air pollutants, however, would be greater than for the non-thermal processing alternatives, though ground level increments would be significantly less than ambient air quality standards. Similar to the other thermal processing alternatives, stringent particulate controls would minimize problems with respect to heavy metals; trace organics would also be destroyed. Capacity in Milliken landfill would be required for disposal of residuals. Freshwater required for thermal cooling would represent a significantly high percentage of the total supplied by the local system.

Barge Disposal (4R1): Information on the effects of deepwater discharge is limited. As a result, a considerable amount of background data would be required before potential impacts could be identified. Broad dispersal of sludge solids would result. However, modelling studies indicate some disposition of solids on the ocean bottom. In view of the experience with existing outfall systems, it might appear reasonable to conclude that some adverse effects would be experienced by the affected benthic community.

Baseline No-Project (6S1): A number of adverse impacts would be associated with implementation of this alternative, which would include composting, landfilling, and ocean disposal of sludge. These would include potential problems with odors, noise, and dust at the treatment plant sites, the landfills, and possibly along the transportation routes. Significant public health concerns would exist with respect to air pollutant emissions because of the use of internal combustion engines, with uptake of trace organics by marine organisms, and probably with heavy metals if compost were used over an extended period of time to grow food chain crops. Existing congestion and vehicular conflicts on major arterials and local streets could also be aggravated. The capacity of the Lopez Canyon landfill would be reduced to some extent by disposal of sludge.

RANK ORDERING OF ALTERNATIVES

Although adverse impacts would be associated with the implementation of all the alternatives, as indicated above their severity could be reduced in many cases through implementation of appropriate mitigation measures. Adverse impacts that could be mitigated to relatively acceptable levels included those involving archaeological resources at the CLA-LAX site, Round Canyon, and the desert regional sites; air pollutants with all but the Baseline No-Project; heavy metals with the energy recovery/thermal processing alternatives; and probably sensitive terrestrial biotic species at the CLA-LAX site. Although the mitigation measures identified for adverse impacts associated with nuisances would probably not be completely effective in eliminating potential problems, they would reduce their severity to somewhat more acceptable levels.

In general, no weights were assigned to the environmental considerations in establishing the relative merits of the alternatives. For example, although public health is a significant concern, potential adverse effects caused by air pollutant emissions were not regarded as more important than potential adverse effects on other environmental considerations. However, any impact that was judged to be significantly adverse was regarded as considerably more serious than impacts judged to be simply adverse, particularly if the impacts were essentially unavoidable.

The distinctions that were made between these two levels of importance are reflected in the ranking and grouping of alternatives with respect to their

environmental acceptability. Based upon the criterion of significance, the alternatives with the least number of adverse impacts were judged to be relatively more preferable than others, regardless of which environmental considerations were involved. These alternatives were assigned to Group I. Conversely, the alternatives with the greatest number of significant, unavoidable adverse impacts were assigned to Group IV. Decisions made with respect to Group II and III were generally based upon the relative degree of severity between these two extremes.

Group I

Energy Recovery from Sludge (3S1) followed by Energy Recovery from Sludge and Solid Waste (3S2) were judged to be the most environmentally acceptable alternatives, since their implementation would not entail any significant, unavoidable adverse impacts. While there would be some concerns for visual conflicts and nuisance problems, these would not be appreciably different from those associated with other alternatives judged to be less preferable.

Group II

Truck Dewatered Sludge to Landfills (DS1) was judged to be less preferable than the Group I alternatives, but somewhat more acceptable than the highest ranked Group III alternative. Potential nuisance problems would generally be similar to most of the other alternatives, while the potential for traffic problems and reductions in landfill capacity would be somewhat more than for all other alternatives.

Group III

A range of adverse impacts would be associated with the Group III alternatives, including potentially significant disturbances to sensitive biotic species and aesthetic problems (2S1-X), some concerns regarding heavy metals (2S1, 2S1-X), relatively high reductions in landfill capacity (2R1, 3R1), and high requirements for freshwater (2R1, 3R1). Although distinctions between the alternatives were difficult to make, they were generally ranked as follows: Decentralized Dewatering and Composting (2S1), Round Canyon Composting/Air Drying (2S1-X), Centralized Dewatering and Composting (2R1), and Energy Recovery from Sludge and Dairy Waste (3R1). Deep Ocean Outfalls (4S1) and Barge Disposal (4R1), were also included in Group III. However, their relative positions within the group was not determined because of the number of unknowns and uncertainties associated with their implementation.

Group IV

The least acceptable alternatives were judged to be in descending order Solar Drying Basins (1R1), the Desert Energy Project (1R2), and the Baseline No-Project (6S1). The desert regional alternatives would cause major visual conflicts and significant disturbances to sensitive biotic species. Public health would also be of some concern with respect to heavy metals (1R1) and air pollutants (1R2). Potential nuisances could also constitute major annoyances in neighboring areas. Potentially significant public health risks would be associated with 6S1 - air pollutants and possible accumulation of trace organics in marine organisms. In addition, heavy metals would also be of some concern. Some problems could also be expected with respect to nuisances and vehicular congestion/conflicts.

ADVANTAGES/DISADVANTAGES

To this point the discussion has centered on the individual considerations of quantitative engineering analysis, engineering practicality, environmental acceptability, and implementation potential. Attention will now be focused on drawing these individual analyses together into a comparative framework. The following section will serve as transition from the considerations discussed individually in previous chapters to the proposed plan discussed in the following chapter. They will also form the basis for a discussion of risks and benefits associated with the proposed program. The comparison will begin with a discussion of the advantages and disadvantages of each project and conclude with elimination of some projects from further consideration.

The following list of advantages and disadvantages for each project was compiled by LA/OMA staff based upon consultant reports, staff studies, demonstration project results and other in-house information.

PROJECT 1R1 - SOLAR DRYING

The major advantages and disadvantages of Project 1R1 are outlined as follows:

ADVANTAGES

- Good long range economics. The Project is low in cost on the basis of present worth, and agency share of the present worth.
- Low cost on the basis of agency share of current annual costs.
- 40+ year facility life for digesters, pipelines, and solar drying basins.
- High reliability and relatively easy operation.
- No requirement for mechanical dewatering.
- Use of solar energy for drying.
- System could be readily designed to incorporate sludge from other adjacent communities.

DISADVANTAGES

- High capital costs.
- Limited resource recovery potential for dried product in the desert areas.
- Susceptibility of the pipeline and other facilities to earthquake damage.
- Successful implementation would require active involvement of state and federal agencies.
- Strong local opposition to the project has been voiced.
- Felt to have the longest implementation period of all projects considered.
- Environmental concerns center in the following areas.
 - Potential nuisances such as dust, odor, noise.
 - Destruction of biotic community along portions of the pipeline route and at solar drying site.
 - Potential hazard to migratory birds from open lagoons.
 - Some stress to one rare and endangered species, depending on site.
 - Visual disturbances.
 - Exposure to heavy metals from wind blown dried sludge, or reuse of dried sludge product to grow food chain crops.

PROJECT 1R2 - DESERT ENERGY PROJECT

Major factors for Project 1R2 are similar to those for Project 1R1 with the following additions.

ADVANTAGES

- Lowest agency share of present worth of all projects examined.
- Maximum insulation from inflationary effects of all projects examined.
- Resource recovery provided through energy recovery from dried sludge.
- Destruction of trace organic compounds during thermal processing.

DISADVANTAGES

- Highest capital cost of all projects considered.
- Thermal processing would add air emissions to a clean air basin. Mercury emissions could exceed new source performance standards.
- Some stress on local water supplies could be expected to meet cooling water requirements. Use of closed loop cooling systems or reclaimed wastewater would reduce the problem.

PROJECT 2S1 - DEWATERING AND COMPOSTING BY EACH AGENCY

ADVANTAGES

- Project falls in the midrange of values for both long and short range economics (i.e. present worth and current annual costs).
- Resource recovery is provided through reuse of sludge organics as a soil amendment.
- Established markets exist for sludge based products.
- Dependency on local landfills is reduced.

- Process is less complex than thermal; processing, particularly if sludge dehydration is not used.
- If necessary, compost can be readily landfilled as a normal Group II waste.
- Some community support for recycling was voiced.
- Direct air emissions are lower than for thermal processing projects.
- Minimal or no impacts on water quality.

DISADVANTAGES

- Mechanical dewatering is required and the composting operation is sensitive to feed cake solids content.
- Processing of waste activated sludge is difficult and involves some unknowns.
- Mechanical composting systems have had limited prior application to municipal sludges.
- Local community concern was voiced over potential nuisances.
- High pathogen monitoring effort is anticipated unless pasteurization is used.
- Health related regulations on use of compost are lacking at the present time. Compliance with EPA pretreatment levels or sludge segregation are likely to be required for marketing.
- Land requirements could constrain the amount of sludge composted. This will depend on the level of secondary treatment required at each plant. The most severe restrictions occur at Hyperion.
- Major environmental concerns center in the following areas.
 - Potential nuisances such as odors, noise and dust.

- Exposure to heavy metals from use of compost product to grow food chain crops.
- Visual disturbances around the treatment plant sites.
- Some decrease in landfill capacity if compost has to be landfilled.

PROJECT 2S1X - ROUND CANYON PROJECT, OCSD

The Round Canyon composting project for OCSD would involve truck hauling of dewatered sludge cake to a processing site at Round Canyon, where the sludge would be windrow composted. The composted sludge could be reused in the future, provided adequate sludge quality is achieved, but the present plan calls for disposal in landfill because of relatively high heavy metal concentrations in the sludge.

ADVANTAGES

- Prospects for rapid implementation are good.
- Capital and O & M costs are slightly lower than the corresponding in-plant 2S1 project.
- The net electricity available would be higher than the corresponding in-plant 2S1 project. Even with deduction of equivalent energy in diesel fuel used for trucking, net energy generated would still be higher than Project 2S1.
- Neighborhood acceptance may be higher compared to the in-plant 2S1 project because the Round Canyon area is relatively isolated.
- The proposal for the Bee Canyon landfill adjacent to Round Canyon would enhance the prospect of the project, but its development would not be essential since composted sludge could be hauled to other landfills.

DISADVANTAGES

- Round Canyon has been identified to contain significant and sensitive archaeological resources, but these can be protected by an appropriately designed cultural resources program.
- Visual conflicts would occur in the future if surrounding vacant land were developed for residential use.
- Public input on the project, especially from neighbors around Round Canyon, was indeterminate, due to lack of public interest.
- The Project is more susceptible to wet weather operational problems than other projects.

PROJECT 2R1 - CENTRALIZED DEWATERING AND COMPOSTING

Advantages/Disadvantages for Project 2R1 are similar to those for Project 2S1 with the following changes and additions.

ADVANTAGES

- Windrow composting could be used in place of mechanical composting which results in lower capital costs.
- Sludges from other communities could be incorporated into the system.

DISADVANTAGES

- Implementation is dependent upon active involvement of state and federal agencies.
- Equivalent levels of pretreatment would likely be required by each sewerage agency.
- Well defined advantages compared to Project 2S1 are generally lacking.

- Major environmental concerns are similar to 2S1 with the addition of potential problems in meeting water demands.

PROJECT 3S1 - ENERGY RECOVERY FROM SLUDGE

ADVANTAGES

- Project falls in the midrange of values for both long and short range economics.
- Resource recovery is provided by conversion of sludge organics to energy. Energy recovery is about 50 percent greater than for non-thermal projects.
- Dependence on landfills is reduced.
- The dehydration system is less subject to upstream dewatering performance than other processes such as composting.
- Some support was voiced by interest groups.
- Truck traffic near the treatment plants is lower than for other in-plant projects.
- Organic toxicants will be destroyed during thermal processing.

DISADVANTAGES

- The dehydration system, thermal processing, and sophisticated air cleanup trains have had limited prior application on municipal sludges.
- The system is highly complex and requires skilled manpower.
- Direct air emissions are greater than for non-thermal projects.

- Minimal health effects are expected for heavy metal discharges, but this projection is dependent on achieving stringent particulate control.
- The potential exists that air quality requirements will be changed and require more advanced control technologies.
- Major environmental concerns center in the following areas.
 - Potential nuisances such as odors, noise, dust.
 - Visual disturbances near the treatment plant site.

PROJECT 3S2 - ENERGY RECOVERY FROM SLUDGE AND SOLID WASTE

Advantages/Disadvantages for Project 3S2 are similar to those for Project 3S1 with the following changes and additions.

ADVANTAGES

- Sludge dehydration is not required to achieve autogenous combustion.
- A partial solution to solid waste disposal problems is provided.
- Energy production can be increased by incorporation of greater amounts of refuse.

DISADVANTAGES

- Increased refuse truck traffic near treatment plants and along route.
- Higher levels of direct air emissions compared to Project 3S1.
- Dependence on solid waste to achieve an autogenous process.

- Need for refuse processing facilities at or near the waste water treatment facilities.

PROJECT 3R1 - ENERGY RECOVERY FROM SLUDGE AND DAIRY WASTE

A regional codisposal system with manure shares many of the same advantages and disadvantages of other thermal processing projects. The following additions and changes are applicable.

ADVANTAGES

- A partial solution to dairy waste management problems is provided.
- The system could be designed to incorporate sludges from other adjacent communities.

DISADVANTAGES

- Since dehydration of the sludge would be required to produce an autogenous mix, there is no compelling advantage of this project compared to Project 3S1.
- Some difficulty with new source performance standards for Hg may be encountered.
- Environmental concerns center in the following areas.
 - Decreased landfill capacity.
 - Potential nuisances such as odors, noise, and dust.
 - Visual disturbances.
 - Freshwater required for cooling would represent a significantly high percentage of the local supply.

PROJECT DS1 - LANDFILL DISPOSAL

ADVANTAGES

- Capital investment is lowest of all projects except Baseline Project (6S1).
- Potential exists for resource recovery through enhanced landfill gas production.
- System offers low complexity and low operator skill and is rated as highly reliable.
- The potential for containment of toxicants is probably highest of all projects examined.
- A short implementation period is projected.
- System is characterized by good long range economics if enhanced landfill gas recovery is realized.

DISADVANTAGES

- System is characterized by poor long range economics and high agency costs without enhanced landfill gas recovery.
- The system is dependent on solid waste landfill facilities and may be impacted by disposal of liquid waste at landfills.
- Leachate controls may be required at landfills receiving dewatered sludge cake.
- Mechanical dewatering is required.
- Implementation and continued operation is dependent on local conditional use permits for landfill operation.

- Wet weather poses difficulties for placement of sludge in a landfill.
- A potential health hazard exists from accidental spillage of sludge or tracking of sludge from the site.
- Major environmental concerns center on the following:
 - Potential nuisances such as odors, dust, and noise.
 - Localized and some regional traffic problems.
 - Decreased landfill capacity.

PROJECT 4S1 - DEEP OCEAN OUTFALLS

ADVANTAGES

- Project 4S1 presents the best short and long term economics of all systems examined.
- System offers the highest reliability and easy operation.
- All major facilities would have 40+ year service life.
- No mechanical dewatering is required.
- Negligible dependence on landfills or other solid waste facilities is required.
- Direct air emissions are lowest of all projects examined.
- Some support was voiced from CLA neighbors and the Los Angeles Area Chamber of Commerce.

DISADVANTAGES

- Minimal resource recovery beyond digester gas production is provided.
- Very limited or no containment of toxicants is provided.
- Implementation potential is judged to be very low.
- Minimal public support was indicated by LA/OMA public participation studies.
- Major environmental concerns center on the following:
 - Stress is placed on marine life in vicinity of outfall. Benthic changes near outfall appear to be the most obvious impacts.
 - Concern exists over the potential for sublethal, long term marine effects from toxicants.
 - Lack of sufficient information to adequately predict all environmental effects.

PROJECT 4R1 - BARGE DISPOSAL

Advantages/Disadvantages for Project 4R1 are similar to those for Project 4S1 with the following changes and additions.

ADVANTAGES

- Minimization of local sludge accumulations and reduction of local impacts by encouraging dispersal over large ocean areas.

DISADVANTAGES

- Increased costs, fuel consumption, and air emissions relative to Project 4S1.

- Increased visual disturbances due to barge traffic.
- Legislative prohibition exists.
- Similar environmental concerns as 4S1 with much less concern for benthic changes.

PROJECT 6S1 - BASELINE NO PROJECT

It should be noted that the Baseline Project was included to comply with requirements of NEPA and CEQA for evaluation of a "no project" alternative.

ADVANTAGES

- Construction of additional sludge processing facilities beyond anaerobic digestion would not be required.
- Capital investment is lowest of all projects.

DISADVANTAGES

- Some ocean disposal is involved and implementation potential is judged to be very low.
- Minimal public support was indicated by LA/OMA public participation studies.
- Land based environmental effects would be similar to those described for Projects DS1 and 2S1.
- Potentially significant public health concern with regard to trace organics in seafood taken from outfall areas.
- With respect to marine biota environmental concerns center on:
 - Minimal resource recovery beyond digester gas production is provided.
 - Very limited or no containment of toxicants is provided.

**CONCLUSIONS FROM THE EVALUATION
OF ALTERNATIVE
SLUDGE MANAGEMENT PROJECTS**

IV-98

CONCLUSIONS FROM THE EVALUATION ALTERNATIVE OF SLUDGE MANAGEMENT PROJECTS

Based upon results of the comparative evaluation process and considering the advantages/disadvantages, projects were classified into three groups: those with minimum projects for inclusion in the sludge management program, those which may have improved prospects at a future date, and those with good prospects for inclusion in an indicated sludge management program. The recommended program was subsequently developed from those projects judged to have "good prospects".

The composite results of the qualitative evaluation of alternatives are shown in Table IV-20. Results of the quantitative evaluation are shown in Table IV-21. Examination of the groupings of alternatives with respect to their environment acceptability, engineering practicability, and implementation potential indicated that no single alternative was the obvious "best alternative". The decision as to what was the best alternative(s) involved tradeoffs among the considerations.

Alternatives were grouped through consideration of tradeoffs according to prospects for inclusion in the proposed management program. The tradeoffs involved are discussed by alternative according to such groups in the following sections.

ALTERNATIVES WITH APPARENT MINIMAL PROSPECTS

In general, these alternatives were characterized fairly good long-term economic and engineering characteristics. However, they were either the least desirable in terms of environmental acceptability and/or implementation potential, or they offered no distinct advantages over those that were included in the Program.

Desert Regional Alternatives (1R1, 1R2)

These alternatives would have good, long-range economic feasibility and provide long-term (40 years) facilities for sludge management. However, nuisances, visual disturbances, and ecological stresses on rare and endangered species would be significant environmental problems. In addition, an extensive archaeological mitigation program would probably be required. Without state or federal leadership, prospects for implementation appear low. A new institutional structure involving the LA/OMA operating agencies also would have to be established in order to implement the alternatives. Strong public opposition also has been voiced. Alternative Desert Energy Project (1R2) would have the additional disadvantage of introducing a significant, new source of air emissions into a clean air basin. There would be concern about the possible violation of the mercury mass emissions standard.

TABLE IV-20

GROUPING OF ALTERNATIVE SLUDGE MANAGEMENT PROJECTS
QUALITATIVE CONSIDERATIONS

<u>GROUP</u>	<u>ENVIRONMENTAL ACCEPTABILITY</u>	<u>ENGINEERING PRACTICABILITY</u>	<u>IMPLEMENTATION POTENTIAL</u>	
			<u>REGULATORY COMPATABILITY^a</u>	<u>PUBLIC ACCEPTABILITY^a</u>
I	3S1 3S2	6S1 4R1 4S1 DS1	2S1 ^b 3S1	
II	DS1	1R1 2S1 2S1-X 2R1	DS1 1R1 2S1 ^c 2S1-X	2S1 2S1-X 3S1 DS1 2R1 3R1
III	2S1 2S1-X 2R1 3R1 4S1 ^e 4R1 ^e	1R2 3S1 3S2	1R2 2R1 3R1 3S2	3S2 4S1 4R1 ^d
IV	1R1 1R2 6S1	3R1	4R1 4S1 6S1	1R1 1R2 6S1

SOURCE: DMJM, CH2M Hill, LA/OMA Project.

- The relative position of alternative projects within each group was not determined.
- Los Angeles County Sanitation Districts and Orange County Sanitation Districts only.
- City of Los Angeles only.
- Although 4R1 was not discussed with the public, it probably would be similar to 4S1.
- The relative position of 4S1 and 4R1 with respect to the other alternatives was not determined.

TABLE IV-21
RANKING OF ALTERNATIVE SLUDGE MANAGEMENT PROJECTS
QUALITATIVE CHARACTERISTICS

BALANCED ECONOMIC VIEW		TOTAL DIRECT AIR EMISSIONS ^a	
4S1	Deep Ocean Outfalls	4S1	Deep Ocean Outfalls
4R1	Barge Disposal	1R1	Solar Drying Basins
6S1	Baseline No-Project	2S1	Decentralized Dewatering and Composting
1R2	Desert Energy Project	DS1	Truck Dewatered Sludge to Landfills
1R1	Solar Drying Basins	2S1-X	Composting/Air Drying at Round Canyon
2R1	Centralized Dewatering and Composting	2R1	Centralized Dewatering and Composting
2S1	Decentralized Dewatering and Composting	4R1	Barge Disposal
2S1-X	Composting/Air Drying at Round Canyon	3S1	Energy Recovery from Sludge
3S1	Energy Recovery From Sludge	1R2	Desert Energy Project
3R1	Energy Recovery From Sludge and Dairy Waste	3R1	Energy Recovery From Sludge and Dairy Waste
3S2	Energy Recovery From Sludge and Solid Waste	3S2	Energy Recovery From Sludge and Solid Waste
DS1	Truck Dewatered Sludge to Landfills	6S1	Baseline No-Project

SOURCE: LA/OMA Project

a. Sum of direct air emissions for NO_x, TSP, SO_x, and HC.

The disadvantages were considered to incur too great a risk for the benefits gained. This combination of factors lead to the conclusion that these projects do not have good prospects for a sludge management program.

Fontana Regional Alternative (2R1, 3R1)

The underlying concept for a centralized facility is the ability to collectively process the sludge for maximum nuisance control in a remote area. However, on examination of available sites, there did not appear to be overriding environmental or economic advantages. Nuisances and visual disturbances were of concern with both alternatives, while Energy Recovery from Sludge (3R1) would create a large demand on the local water supply system. Land use permits probably would be difficult to obtain and it appears likely that federal and state governments would have to assume a lead role if implementation were to proceed. In addition, for Alternative 3R1, there would be no particular advantage in the use of dairy waste as a fuel supplement since sludge would still have to be dehydrated in order to support autogeneous combustion.

Barge Disposal Alternative (4R1)

Ocean disposal by barging would provide wide area dispersal of the wide area dispersal of the sludge solids at moderate depth, as compared to the proposed deep ocean outfalls (Alternative 4S1), which would concentrate sludge in a limited area. Implementation potential would be low, however, due to the statutory prohibition against ocean dumping of sludge. It also would involve high air pollutant emissions, high energy consumption, and costs higher than those associated with the use of ocean outfalls. Public interest also appeared minimal regarding this alternative. However, some interest was expressed regarding ocean disposal as an interim measure. Full definition of impacts on marine resources would require additional study.

Baseline No-Project Alternative (6S1)

The Baseline essentially was an interim measure that would not constitute a long-term solution to sludge management. Other measures eventually would have been required had this alternative been selected. In addition, since it included ocean disposal, it would be difficult to continue. It also had the lowest public acceptance of all of the alternatives (although some interest was expressed regarding ocean disposal as an interim measure) and some of the more significant adverse environmental impacts.

ALTERNATIVES THAT MAY HAVE IMPROVED PROSPECTS AT SOME FUTURE DATE

Two of the alternatives appeared to have a potential for improved future prospects, assuming that uncertainties associated with operational difficulties or adverse environmental impacts could be resolved. Both incorporated features that would add flexibility to the selected alternatives or generate additional energy.

Energy Recovery From Sludge and Solid Waste Alternative (3S2)

The main advantage of sludge/refuse co-disposal was that it would not require dehydration, which is a new technology in wastewater treatment applications and has some uncertainties associated with it. This alternative would decrease demand for landfill capacity, a beneficial impact not common to any other alternative. However, it would require an interface between the sludge management and the refuse disposal systems, and possibly be subject to operational transfer hazards and refuse collection strikes. Public objections also were expressed regarding processing of refuse at the treatment plants. Environmental problems would include visual disturbances, nuisances, and a fairly large amount of trucking. This alternative could be reevaluated as a possible future expansion of Energy Recovery From Sludge (3S1), to provide additional energy generation.

In view of the foregoing, prospects for inclusion of this project in the proposed program are not considered great at present, but may improve with time.

Deep Ocean Outfall Alternative (4S1)

Although prospects for implementation of this alternative appear at this time very low, it is considered possible that such potential might improve were more definitive information obtained on probable impacts on the marine environment. Areas requiring additional and/or more definitive research included deep ocean currents and hydrographics, the physical and chemical behavior of sludge in the ocean, and the distribution and abundance of marine biota. Major issues involved minimizing localized impacts, chronic sublethal effects, behavioral changes, and the time scale of the sludge induced stress on the biota and potential for bio-accumulation and attendant health concerns. Development of sufficient information on both the technical and environmental aspects of ocean disposal should result in greater understanding of the marine environment and provide flexibility for future decision making. The public expressed some interest in ocean disposal as an interim measure.

ALTERNATIVES WITH GOOD PROSPECTS

Although not without problems, these alternatives appear to have the fewest number of significant adverse environmental impacts and the highest implementation potential. In most cases, the adverse impacts that were identified for these alternatives generally were of the type that could be mitigated without significantly altering the overall management system. In addition, the alternatives were relatively adaptable to change and energy efficient.

Decentralized Dewatering and Composting Alternative (2S1/2S1-X)

These alternatives appeared to be relatively uncomplicated in terms of engineering practicability, not noticeably objectionable to the public, and highly implementable, particularly at Round Canyon. In addition, a well-established market for a sludge-based soil amendment existed in the local area. Although uncertainties existed with respect to wet weather operations, studies indicated that the long-term potential was good for successful year-round composting.

A number of adverse environmental impacts were identified for this alternative, but the more significant ones appeared to be mitigable. Industrial pretreatment and pasteurization could reduce potential public health problems associated with toxicants and pathogens. Should these prove ineffective or not immediately implementable, the compost could be landfilled rather than recycled. The archaeological sites at Round Canyon were considered potentially significant cultural resources, but their protection could be assured by further investigations designed to develop an adequate mitigation program. Truck traffic, aesthetic problems, and decreased landfill capacity would remain concerns, but not more so than with any of the unselected alternatives.

Energy Recovery From Sludge Alternative (3S1)

Project 3S1 would provide about 50 percent more energy than the non-thermal alternatives. With credits from the energy generated, costs would be about mid-range. Public acceptance appeared to be conditioned upon minimization of pollutants and nuisances. There also was some uncertainties regarding the performance of the dehydration system, the thermal processing reactor, and the air pollutant clean-up equipment. However, technical studies indicated good long-term potential for successful operation.

Although this alternative had the least number of adverse environmental impacts, air pollutant emissions were among the highest of all alternatives. However, implementation of best available control technology and coordination of tradeoff strategies with air quality management planning would provide a means to reduce

them to within allowable limits. Aesthetic problems would remain a concern, but not significantly more so than with any of the other alternatives.

Truck Dewatered Cake to Landfill (DS1)

This project would be easily implementable, providing permits were obtained in a timely manner. Potential toxicants and pathogens also could be effectively controlled through containment. In general, public acceptance appeared to be somewhat neutral, or indeterminate although an interest in resource recovery rather than disposal had been clearly indicated.

Adverse environmental impacts associated with this alternative were essentially unmitigable. These included a significant demand on landfill capacity, a large amount of truck traffic, and a fair amount of nuisances. The alternative also had relatively poor long-range economic feasibility, though there would be good future potential for energy credits from enhanced landfill gas production. It also would be dependent on the refuse management system and subject to some operational difficulties during wet weather. Extensive gas collection and odor control systems also might be required.

CONCLUSIONS

Based upon the relative advantages and disadvantages associated with each alternative and their relative overall desirability, it was concluded that:

- Decentralized Dewatering and Composting (2S1 and 2S1X), Energy Recovery from Sludge (3S1), and Truck Dewatered Cake to Landfill (DS1) would provide the best long-term prospects for inclusion in the Proposed Sludge Management Program.
- Energy Recovery from Sludge and Solid Waste (3S2) could, from a technical point of view, be implemented at some future date as an expansion of Project 3S1.
- Deep Ocean Outfalls (4S1) appeared to offer better prospects than Barge Disposal (4R1), although additional study would be required before a definitive conclusion could be reached regarding either option.
- Solar Drying Basins (1R1), the Desert Energy Project (1R2), Centralized Dewatering and Composting (2R1), and Energy Recovery from Sludge and Dairy Wastes (3R1) appeared to have the poorest prospects for sludge management.

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CHAPTER

V

CHAPTER I

**BACKGROUND AND
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CHAPTER V

DESCRIPTION OF THE PROPOSED SLUDGE MANAGEMENT PROGRAM

The proposed sludge management program has resulted from comparative evaluation of twelve alternative sludge management projects. In summary, evaluation of the alternative projects was conducted with regard to environmental acceptability, engineering practicability, quantitative characteristics (e.g. cost, energy, air emissions), and implementation potential (which included public acceptance). The best prospects for selection of a sludge management program were found to center around --

- Decentralized Dewatering and Composting
- Energy Recovery from Sludge
- Landfill Disposal of Dewatered Sludge

In general, comparative evaluation of the alternative projects disclosed few clearly definitive distinctions among alternatives. From an economic standpoint, the major distinction was found to be between ocean disposal and land based projects in general. Economic differences among land based projects were generally with regard to short-term versus long-term economic characteristics. However, in terms of current annual costs, economic differences among the land based projects were within the range of precision of the cost estimates. Technological uncertainty, while of significant interest, was not believed insurmountable and did not rule out alternatives. Nuisance and neighborhood concerns were considered very seriously but generally affected conclusions regarding new locations, incorporation of features to minimize nuisances, and concern for continuance of practices which have produced nuisance conditions in the past.

While environmental evaluations disclosed differences among projects, potentially significant adverse impacts were largely associated with ecological factors principally related to desert areas and ocean waters. Significant potential archaeological impacts were also identified with respect to desert areas and Round Canyon. In the final analysis, these results, when coupled with the capability

for timely implementation, lead to selection of the composting, thermal processing, and landfill disposal alternatives as the foundation for the sludge management program. While these alternatives are not without potentially adverse impacts, such impacts are believed to be amenable to mitigation to reduce severity of impacts to acceptable levels.

Concern for public health was a major environmental issue common to all alternatives. Among the major findings to this regard were that minimal adverse health effects were expected as a result of ground level air pollutant concentrations for all projects, with the exception of the Baseline alternative (6S1), heavy metals were of concern for those alternatives involving composting/reuse and/or thermal processing, trace organics were of potentially significant concern only for ocean disposal alternatives, and for all alternatives, pathogenic microorganisms were expected to be either destroyed, contained, and/or dispersed so as to reduce the likelihood of disease transmission to an acceptably low level.

Two of the alternatives, Energy Recovery from Sludge and Solid Waste (3S2) and Deep Ocean Outfall (4S1), were judged to potentially have improved prospects at some point in the future, assuming that uncertainties associated with public acceptance and environmental consequences are resolved. Codisposal with refuse at the treatment plants is not precluded by the proposed program and may be incorporated at some future date if public acceptance problems can be overcome. Ocean disposal in deep waters by outfall or barge disposal requires development of more definitive information on probable impacts upon the marine environment.

MAJOR FACTORS
ASSOCIATED WITH PROGRAM SELECTION

During the alternatives analysis, several items of concern were raised by technical studies and experts and by the public through the LA/OMA Project public participation program. While items were identified for all alternatives, factors related to decentralized dewatering and composting, energy recovery from sludge, and landfill disposal of dewatered sludge are most important to selection of the proposed sludge management program. The following discussion focuses on principal factors affecting program selection and provides a context for understanding the proposed program and its attendant environmental impacts.

AIR QUALITY

Air quality is a major existing environmental problem in the LA/OMA urban area. Incorporation of effective control measures in the sludge management program is judged to be essential to public acceptance of the program.

Opportunity exists for substantial reductions (from 1978 levels) in emissions of hydrocarbons (HC) and oxides of nitrogen (NO_x) at each of the treatment plants. These reductions would be achieved principally through conversion from internal combustion engines to turbine generating systems. With the energy recovery alternative, potentially significant increases in emissions of oxides of sulfur (SO_2) and relatively small (100 pounds per day) increases in particulate (TSP) emissions may result. Reductions in TSP emissions were indicated for the composting and landfill alternatives.

With respect to SO_2 , technology exists for reduction of emissions from those levels projected for the viable alternatives. Removal of hydrogen sulfide from digester gas appears feasible. Additionally flue gas desulfurization systems may also be used as necessary. TSP emissions, although not large in magnitude, generally would be a function of air cleanup technology that is expected to improve.

Emissions of NO_x though less than 1978 levels, are of major concern considering current ambient air quality conditions and uncertainties associated with emissions estimates. Technology for NO_x reduction has been identified and applied to emission sources in Japan. In view of the concern for NO_x emissions and the apparent imminence of control technology, it is reasonable to expect that NO_x removal will be established as "best available control technology" by air quality control agencies at some time during the next 10 years.

The Air Quality Management Plan (AQMP) has identified allowable emission levels that are expected to result in attainment of state and federal ambient air quality standards. AQMP has also identified actions to achieve emission reductions

required to achieve ambient air quality standards. In view of the regional nature of the sludge management and air quality problems, and since sludge management is an integral component of the regional infrastructure, it is appropriate that efforts to manage sludge and air quality be mutually supportive. The sludge management program should minimize air emissions consistent with the needs for sludge management, while Air Quality Management Planning should identify and provide for emission reductions on a regional basis as needed to accommodate sludge management needs while providing for acceptable air quality.

In addition to concern for ambient air standards on a regional basis, concern also exists with regard to localized ground level impacts. As necessary, stack discharge systems could be employed to provide for attainment of ambient air quality standards at the point of maximum ground level impact.

NUISANCE POTENTIAL

The treatment plants are bordered at least in part by residential development. In the past, concern has been expressed by treatment plant neighbors regarding nuisance potential of the wastewater treatment plants. Odors, dust, and noise generated during treatment and/or transport of the sludge are thus expected to be potential problems. Screening or enclosure of the facilities and effective control of dust and odor emissions should be incorporated to minimize or prevent development of nuisance conditions.

SLUDGE QUALITY

Presence of pathogenic organisms and toxicants in sludge is of concern because of the potential for human health effects and possible environmental impacts.

Human pathogenic organisms include bacteria, virus, and parasites. It is essential that sludge be adequately processed to inactivate these organisms so that public health hazards are avoided. Anaerobic digestion destroys some organisms, however, substantial numbers remain in the digested sludge. Thus, additional pathogen destruction must be provided in subsequent unit processes if use of the final processed sludge by the public is envisioned. A well designed and properly operated composting system is one means for providing additional pathogen destruction. Pasteurization systems, however, may prove necessary if as-yet-to-be-issued regulatory requirements cannot be met by composting systems alone.

Toxicants of principal concern are trace metals and various trace organic compounds. The presence of these substances in trace amounts in the sludge reflects their general use and presence in our society. These substances tend to become associated with sludge particles during wastewater treatment. Because of low

levels present in LA/OMA sludges, concern is directed principally to consideration of potential effects of chronic exposure to low levels of these substances.

Many of the trace organic compounds that are discharged to the sewer are easily degraded into harmless substances by wastewater treatment and natural processes. Others, however, are persistent and not easily degraded. Some persistent compounds, chlorinated hydrocarbons are an example, tend to accumulate in organisms, including man, over a long period of time. While all trace organic compounds are of some concern, major attention has been focused upon the persistent trace organic compounds.

Trace metals is a term applied to a group of metallic elements that are present in natural systems in low concentrations. In small quantities many trace elements are essential to properly functioning biological activities. However, excessive accumulation in biological systems can lead to detrimental effects. Elements of special concern in concentrations found in LA/OMA area sludges are cadmium, lead, silver, zinc, copper, and chromium. Not all trace metals exert the same effects. Cadmium, for example, is concentrated in some crops, particularly leafy portions of plants. On the other hand, silver, lead, and zinc have been shown to accumulate in invertebrate marine organisms. Copper and zinc in excessive concentrations can harm plant growth and reduce crop yields. Trace metals, particularly cadmium and lead, can also become associated with respirable particles.

There are uncertainties associated with determination of long term health and environmental consequences associated with trace metals and trace organics. Quite obviously, however, controls are appropriate. It should also be noted that there are many sources of trace metal discharges to the environment. Evaluation of effects of sludge quality should be cognizant of the other sources of trace metal discharge in our society and consider potential physiological responses associated with ingestion into the body via consumption of food, smoking, and inhalation of respirable particulate matter, and potential effects upon both short term and long term health of the physical environment.

Reduction of trace metal concentrations in sludges appears most practical through source control programs which preclude discharge of undesirable substances to the sewer system. The LA/OMA operating agencies have industrial source control programs in operation. Historically, emphasis has been on preservation of treatment plant effluent quality. However, emphasis is expected to broaden to include preservation of sludge quality as required by the sludge management program. It should be noted that prospects for source control of chlorinated hydrocarbons may be low since there are no known discrete industrial discharges.

Substantial reductions in certain trace metals concentrations in sludge are expected with implementation of industrial pretreatment requirements established by EPA in 1979. However, with decreasing contributions from industrial sources, domestic contributions become a larger proportion of the total amount of heavy

metals discharged to the sewer system. Thus, industrial source control programs are subject to diminishing returns and further reductions in toxicant concentrations would require action to control and reduce domestic sources.

It would appear that the only practical means for reducing contributions of undesirable substances from domestic and uncontrollable sources to the sewer system would be to eliminate use of such substances from society. Such action would require a determination that reductions in excess of those achievable solely through industrial source control are in fact necessary. In all probability, a significant amount of time would be required before resultant effects, if any, would be seen from such controls.

Society views the sewer system as a convenient and appropriate means of waste disposal. Access to the system is easy and widespread through the manholes that are required for maintenance purposes and are placed throughout the system. Thus, it will be difficult to prevent determined individuals from dumping wastes into the sewer system without the knowledge of the operating agencies. This practice could become widespread if efforts to control nonsewerable waste sources are viewed as an unnecessary burden and there are no economically attractive alternatives available.

Increased attention to management of municipal sludges has also focused attention on development of regulations governing sludge management activities. Section 405 of the 1977 Amendments to the Federal Water Pollution Control Act requires EPA to issue regulations governing issuance of permits for disposal of sludge and including guidelines for disposal and utilization practices. As of December 1979, the final regulatory picture is far from certain. Regulations are under development by EPA and have been the subject of intense discussion for several years. It seems reasonable to conclude that practices which are rendered unacceptable by the regulations, when they are finally promulgated, would need to be modified to be in compliance with the regulatory requirements. Thus, uncertainty as to long term prospects for use of facilities is introduced as a result of the unknown regulatory requirements that will be forthcoming from EPA. Other regulatory requirements and EPA policy, however, specify cessation of ocean disposal as soon as possible and no new ocean discharges of sludge. Thus, it is necessary to move ahead with a management program.

LANDFILL AVAILABILITY

Landfills will play a key role in sludge management as backup systems for use during times of equipment or process malfunction and for sludge disposal until planned facilities become available. Use of landfills for sludge disposal is affected by attitudes of landfill neighbors, need for management of other liquid wastes and operational concerns.

Liquid waste disposal in landfills is of concern from a regulatory and operational standpoint. Regulatory requirements generally limit the ratio between liquid and solid waste or specify the liquid content and nature of wastes that may be placed in the landfill. Near term prospects for closure of certain landfills which provide for liquid waste disposal raises the prospect that such liquid waste will be distributed to other landfills for disposal. The potential increase in liquids received at landfills used for sludge disposal, when coupled with the water content of dewatered sludge, generates concern for potential regulatory and operational problems.

Solid waste in landfills can be used to absorb liquids. However, if the absorptive capacity of solid waste in the landfill is exceeded, leachate will be produced. Such leachate may be of poor quality and must be managed to avoid water quality and potential nuisance conditions. In some cases, regulatory agencies specify leachate control systems as a condition of approval.

Landfill operations are affected by a number of factors. Climatic conditions affect the operation since the operating area is reduced during wet weather. Thus, during dry weather greater amounts of dewatered sludge can be mixed with incoming solid waste on a larger operating area. Other concerns such as customer complaints, odor generation potential, landfill deck stability, and pending site management have been expressed. However, while it is believed that coordinated operation of the landfill and sludge processing facilities can lessen the severity of some operational problems, substantial concern exists on the part of operating agencies regarding long term prospects for disposal of dewatered sludge in landfills.

From a different perspective, however, landfills might be able to be designed to receive high volumes of liquid and organic wastes and operated to recover landfill gas. Solid waste and dewatered sludge in landfills appear to be a significant potential energy source that could be developed through investigation of landfill gas recovery and cleanup systems and through pursuit of opportunities for their utilization.

Regional Water Quality Control Boards have reviewed the characteristics of existing landfills and have provided advice regarding physical conditions and apparent suitability for disposal of dewatered sludge. Liquid loading rates have been indicated together with suggested operational procedures. Disposal of dewatered sludge at Class I landfill sites has, however, been discouraged because such capacity will be needed for disposal of hazardous wastes and siting of new Class I sites is becoming virtually impossible from a political standpoint.

MANAGEMENT OF WASTE ACTIVATED SLUDGE

Each of the operating agencies are faced with requirements for management of substantial quantities of waste activated sludge (WAS) resulting from improved wastewater treatment. Studies have shown that WAS has poor dewatering characteristics and may have adverse effects upon performance of downstream unit processes. It is therefore important that unit process selections be cognizant of the potential effect of WAS on process performance. It may be appropriate to provide flexibility for separate WAS handling, if practicable, to avoid substantial impairment of the superior dewatering characteristics of primary sludges. Failure to properly consider WAS effects could be a significant contributing factor to failure of the overall unit process train to function properly.

TECHNOLOGICAL PERFORMANCE

Some of the sludge management processes that would be employed are new in terms of application to sludge management. Major concerns are potential problems that might be encountered during scaleup and whether actual performance will exactly match projected performance. This concern is intensified by uncertainty associated with regulatory requirements. LA/OMA Projects studies in most cases have essentially exhausted returns that could be expected from "paper" investigations and small scale pilot scale work. Further assurances regarding technological performance is, therefore, considered dependent upon operation of larger scale systems.

Concern for technological performance can be alleviated through incorporation of temporary storage and standby capacity in facilities design. Temporary storage can be used (1) to provide a transition between continuous operations (e.g. mechanical dewatering) and intermittent operations (e.g. trucking), (2) to provide capacity for sludge storage during weekends when solid waste facilities are usually closed, (3) to provide wet weather storage to ease operational problems induced by prolonged rainfall, and (4) to provide increased reliability and flexibility by reducing interdependence of discrete unit processes and by allowing processes to operate under constant feed conditions independent of fluctuations in upstream or downstream processes.

Standby capacity is desirable for several reasons. One, the state of the art for sludge management is being advanced in many technological areas. Increased redundancy within the system will increase reliability of operation of sophisticated high technology processes. Two, there are limits with respect to the ability to accurately forecast operating conditions. Experience has shown that full scale operating performance is difficult to precisely predict, even when pilot testing has been conducted. Adequate standby capacity and conservative design approach can provide backup to projections of operational performance. Three, standby capacity and temporary storage can provide backup operation when other parts of the system are experiencing operational difficulties or are shut down for maintenance.

COMPOSTING

Compost processes have in the past been the source of nuisance complaints and concern regarding reliable pathogen destruction. Exposure to the elements, improper mixing, and excessive drying have been noted as contributory factors. Studies indicate that a generalized relationship exists between nuisance potential and degree of control of the compost process as shown in Figure V-1. In general it can be seen that as the degree of control increases, potential for nuisance problems decrease.

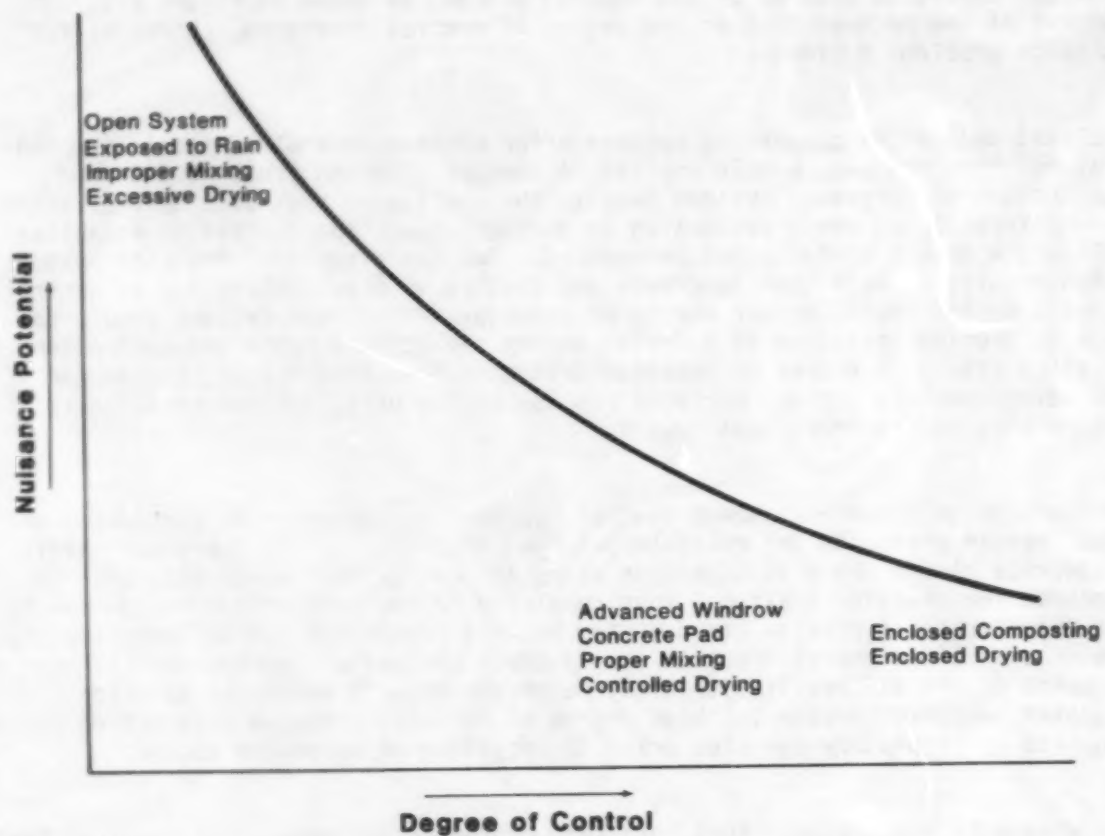
Enclosed mechanical composting systems offer maximum control of nuisance potential but have not been widely applied to sludges. LA/OMA field studies and examination of operating systems lead to the conclusion that such systems offer good potential but merit evaluation on a modest operational scale to establish full scale design concepts and parameters. Two basic types of enclosed systems, batch feeding at wide time intervals and continuous flow systems fed at generally short time intervals, appear worthy of consideration. Both systems should be able to provide agitation of material during the compost cycle and controlled aeration rates. A number of possible drying systems should also be examined including open air drying, enclosed reactor drying using ambient or slightly heated air, and indirect heat drying.

In addition to improved process control, pasteurization prior to composting would also improve prospects for reliable pathogen destruction. It appears possible to pasteurize sludge prior to digestion using the energy that would otherwise be expended for digester heating. Heat remaining in the pasteurized sludge fed to the digester could provide for digester heating requirements with approximately the same level of energy input to the system. Obviously, cognizance will need to be taken of the difficulties that may be encountered in modifying existing digester systems. However, a high degree of reliable pathogen destruction may be required by regulatory agencies prior to recycling of composted sludge.

In summary it would appear that long term prospects for composting requires that additional modest scale demonstration studies be conducted to firmly establish design criteria and process characteristics.

ENERGY

Treatment and disposal of wastewaters for protection of public health and the environment consume substantial amounts of energy. Current and planned wastewater facilities serving the Los Angeles/Orange County Metropolitan Area are estimated to require about 920,000 KWH/day. Addition of full secondary treatment is projected to increase the demand to as much as 1,700,000 KWH/day. Sludge processing and disposal can add to this demand.



☐ **NUISANCE POTENTIAL-PROCESS
CONTROL RELATIONSHIP FOR
COMPOST SYSTEM**
REGIONAL SLUDGE MANAGEMENT PROGRAM
LOS ANGELES-ORANGE COUNTY METROPOLITAN AREA **FIG. V-1**

The precipitous rise in energy prices during the 1970's has generated considerable interest in conservation of this precious commodity. Nationally, emphasis has been given to development of alternative energy sources and conservation of resources as means to reduce dependence upon foreign oil. In January 1978, the California Public Utilities Commission adopted a resolution encouraging cogeneration projects (which include projects which produce power through use of alternative fuels such as sludge). This resolution significantly changed the economics of power generation at wastewater treatment plants and encourages the use of inplant energy recovery systems.

Sludge can be a net supplier of energy. Anaerobic digestion and thermal processing are two means for release of the energy contained in the sludge solids. Anaerobic digestion produces digester gas from the raw sludge which can then be combusted to produce steam and electricity. Thermal processing produces fuel gases which can also be combusted to produce steam and electricity, however, some energy must be expended to dry the sludge solids and avoid use of fossil fuels. Net excess energy (after sludge processing demands are subtracted) could be realized from thermal processing of the sludges produced by current and planned wastewater facilities.

Electricity produced from sludge can be used to partially supply wastewater treatment and sludge management needs. Steam can be used to dry the sludge prior to thermal processing so that use of fossil fuels can be avoided. Steam can also be used for digester heating and pasteurization of sludge solids. Unexplored opportunities for use of waste heat may also exist and might be developed during design of facilities.

It is likely that societal demands for wastewater treatment will continue. Thus it is reasonable to assume that energy demands for wastewater treatment and sludge management will occur regardless of whether or not energy is recovered from the sludge. The magnitude of the demand will be dependent upon the nature of facilities needed to meet regulatory requirements. It is evident, however, that if energy is not recovered from the sludge, the demands will of necessity be met by electrical utility companies. Recovery of energy during sludge processing is therefore an energy conservation measure since use of such energy to meet wastewater treatment and sludge management needs would reduce demand upon electrical utility generating systems, thereby resulting in a reduction of fossil fuel use by utilities.

Implications for air quality are obvious. Opportunities for mitigation of air quality concerns have been discussed in prior sections and will not be repeated. However, it is worthwhile to note that the Legislature and the Governor of the State of California have concurred in legislation (Assembly Bill No. 524, Calvo approved by the Governor September 21, 1979) that encourages development of projects to recover energy and other resources from municipal wastes. Among other things, the statute provides that the State Air Resources Board is to develop revisions to the State Implementation Plan which provide for necessary mitigation of impacts of potential resource recovery projects which are planned

or proposed to be constructed before 1987. The California Air Resources Board is to complete a statewide inventory of such projects by June 30, 1980. The statute also provides that air pollution control districts issue permits for construction of cogeneration technology and resource recovery projects if certain conditions are met. Such conditions indicate that to comply with the provisions of the statute, the sludge management program (a resource recovery project) should (a) be proposed for construction prior to 1987, (b) produce less than 50 megawatts of electricity, (c) employ best available air emission control technology, and (d) provide for good faith efforts on the part of the operating agencies to seek needed emission offsets from facilities owned or operated within the Southern California Air Basin. Such compliance should provide for mitigation of air quality impacts of the proposed program.

RISK PERSPECTIVE

To varying degrees, composting, energy recovery, landfilling and ocean disposal involve (1) public health risks associated with exposure to air emissions, pathogens, heavy metals, trace organics; and (2) ecological risks associated with subtle, long-term biotic changes.

Acknowledging that the acceptance of risk encompasses issues other than technical fact, the following is inherent in the proposed program.

- Elimination of risks that offer no benefit and/or that were easily avoided.
- Elimination of major risks that do not offer clearly overriding benefits.
- Acceptance of small risks that offer benefits and/or that are not easily avoided.
- Active study of the risks defined by these limits with a view towards comparison with risks associated with no action.

With this point of view, the viable alternatives were combined in various ways in order to reduce risks to manageable levels. Consideration was given to factors such as uncertainty of estimates, non-lethal and aesthetic effects, voluntary versus involuntary risks, public attitudes, and risks associated with "no action".

From a public health and environmental standpoint, the specific risk involved would be a function of the nature of the potential effects and resultant consequences, the quality of sludge, the manner of release and transport of substances from the sludge to the affected entity, and the characteristics of the affected entity.

FLEXIBILITY

Sludge management is a never ending responsibility. As long as the wastewater treatment processes are functioning, sludge will be produced. Since it is not possible to terminate the generation of sludge, flexibility should be provided to minimize disruptions resulting from short term unit process malfunctions and changing regulatory and environmental concerns.

A combination of parallel unit process flow trains (multiple process trains) would provide operational flexibility and be responsive to changing regulatory and technological conditions, new environmental information, and unit process malfunctions. Total dependence on a single process train or concept increases the potential for disruptions from such changes. It should be noted that application of this concept may be restricted by other factors such as land availability.

Continued research into the application of new technology will also provide flexibility. Such research would develop information on the viability and performance characteristics that could be used to respond to changes in regulatory requirements and environmental concerns. In addition such research can open up new options which were either nonexistent or uncertain at the time of program development. If research awaits the development of problems from such changes, there will be a delay in the ability to respond to the changes and potentially a period of difficult operations.

A time phased program also would provide flexibility by enabling adaptation over time to technological uncertainty, changing regulatory conditions and new environmental information. Monitoring of operations would need to be conducted to provide information to support a mid-course correction.

SLUDGE VOLUMES AND CAPACITIES

In view of the level of commitment to secondary treatment facilities and uncertainty introduced by the prospects for a waiver of secondary treatment requirements, it appears that as a minimum the year 2000 primary sludge volumes and year 2000 "marine secondary" sludge loads must be accommodated by the facilities plan. This provides for accommodation of primary and waste activated sludges that would be generated by the present level of commitment to secondary treatment facilities and provide flexibility to respond to waiver decisions when such are made.

Final capacity decisions must await detailed project reports which are being prepared to implement the approved facilities plan. However, to prepare a facilities plan and EIS, it is necessary to establish capacities of facilities so that the projected emissions (air, pathogens, heavy metals, trace organics, odors, dust, noise, etc.) and projected inputs (money, energy, labor, land, etc.)

may be identified and environmental impacts defined. It should be noted that unit process capacity decisions will need to consider requirements for redundancy to enhance operational flexibility.

An unnecessary constraint may, however, be imposed if development of the proposed sludge management program does not consider the effects of full secondary treatment of all wastewaters. The sludge management program should therefore include description of options which may be pursued if full secondary treatment of all wastewaters is ultimately required.

PROPOSED
SLUDGE MANAGEMENT PROGRAM

The Proposed Sludge Management Program is a logical outgrowth of the analysis and comparative evaluation of alternatives, as well as consideration of the major factors associated with composting, energy recovery, and landfill disposal. Basic to the program is the concept of minimization of environmental, social, economic, and technological risks involved while providing flexibility to respond to changing requirements, current unknowns, and information gained through monitoring of initial performance of planned facilities.

The proposed program for the Los Angeles/Orange County Metropolitan Area consists of individual management programs for each of the three operating agencies. Elements of the proposed program are --

- Goals and Principles for Sludge Management,
- Conceptual Timeframe,
- Facilities Requirements, and
- Implementation Program.

A description of the program is provided in the following sections. Facilities requirements are described separately for each operating agency following discussion of general provisions of the proposed program.

GOALS AND PRINCIPLES

Program goals establish broadly stated policy direction for preparation of the facilities plan and project reports. The goals of the proposed program are:

- Environmentally, socially, and economically cost effective recovery of resources from wastewater sludges, and
- Reliable management of wastewater sludge to minimize public health risks and environmental degradation.

Principles have been developed to provide specific guidance for key aspects of facilities planning, project report preparation, and sludge management. These principles were derived from examination of the results of the analysis and comparison of alternatives and from review of other sludge management programs.

- Maximum practicable operational flexibility should be provided to enhance prospects for continued resource recovery and avoidance of potential nuisance conditions. As appropriate, opportunity for use of multiple process trains and/or standby equipment should be provided consistent with the remaining principles.
- Emphasis should be placed upon reliable management of waste activated sludge (WAS) and cognizance taken of the potential for the poor dewatering characteristics of WAS to contribute to reduced dewaterability of combined primary and secondary sludges.
- Minimization of nuisance potential should be a major consideration in facilities planning consistent with the other principles.
- Potential consequences that might arise from assumption of risks associated with such factors as regulatory uncertainty, technological performance, changes in sludge character, and emission of heavy metals/trace organics/air pollutants should be considered during preparation of the facilities plan. Adequate standby facilities should be provided.
- Energy conservation should be considered in development of the facilities plan and project reports consistent with other principles.
- Maximum effort to control or mitigate air emissions from projects is warranted in light of current ambient air quality conditions and public concern. Close coordination with Air Quality Management Planning (AQMP) and air quality regulatory programs is important.
- Implementation of the proposed program may involve policy actions by other agencies. Such actions should be defined in the implementation program.
- Uncertainty associated with landfill availability should be recognized and provision made to minimize the uncertainty insofar as practicable.
- Appropriate continuing study needs should be identified for issues or items that may have arisen late in the course of the LA/OMA Project or that are beyond the scope of the Project to consider.

- Facilities planning for sludge management should be cognizant of uncertainties associated with decisions regarding waiver of secondary treatment requirements.

CONCEPTUAL TIMEFRAME

The timeframe for implementation of the proposed sludge management program consists of three phases as illustrated in Figure V-2.

Phase I consists of sludge management planning by the LA/OMA Project and concludes with approval of the facilities plan and environmental documents by the State and EPA.

Phase II consists of design, construction, operation, and monitoring of sludge management facilities to firmly establish performance efficiencies and substantiate economic, environmental, and engineering projections while providing for acceptable management of sludge. Decisions regarding expansion, deletion, or replacement of facilities would be made at the conclusion of Phase II or after a reasonable period of operation has provided an adequate basis for such decision. Phase II is anticipated to be concluded within about 10 years after completion of Phase I.

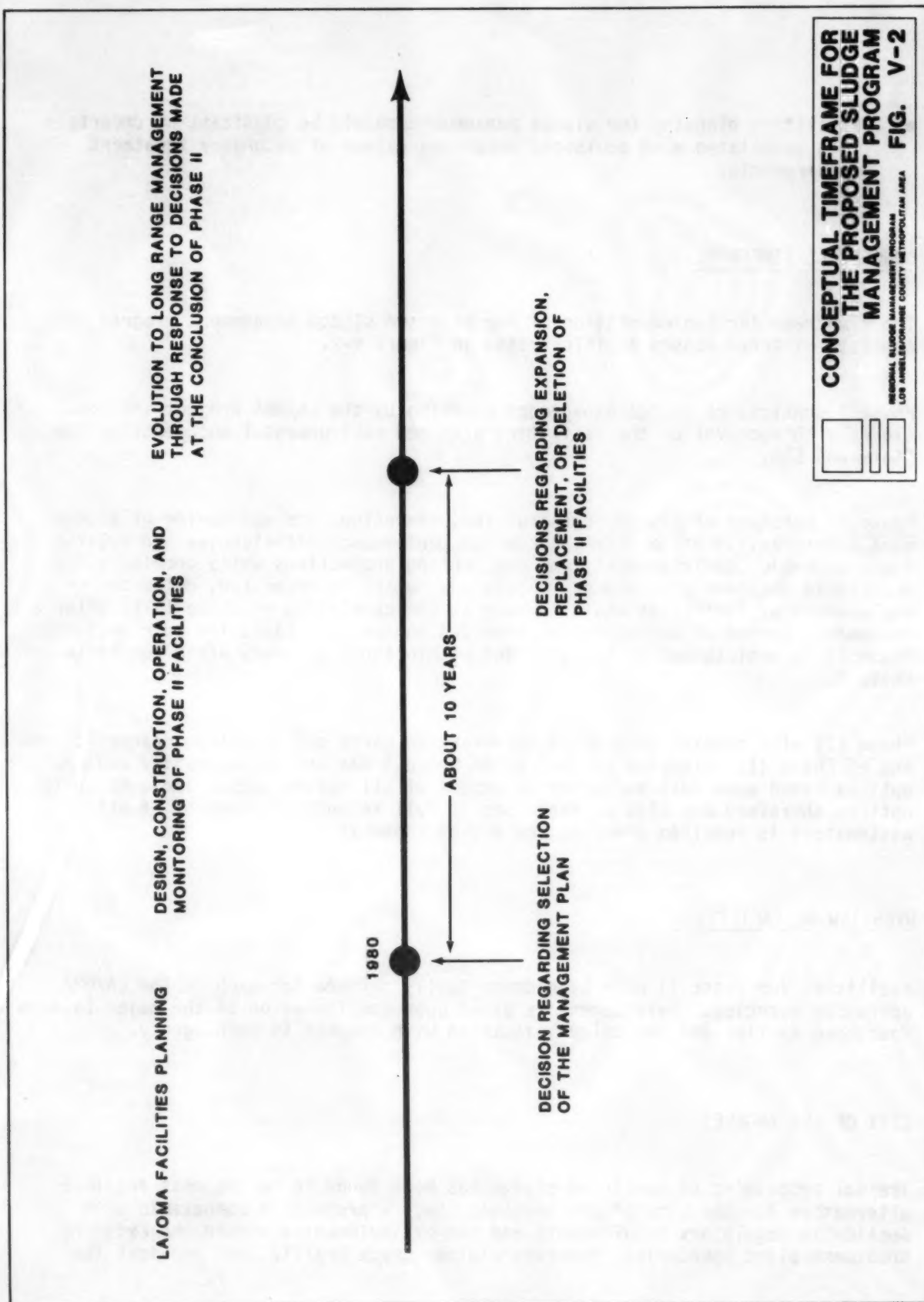
Phase III will consist of actions necessary to carry out decisions reached at the end of Phase II. Planning by the LA/OMA Project has defined currently available options based upon full secondary treatment of all wastewaters. These Phase III options therefore may also be exercised if full secondary treatment of all wastewaters is required prior to the end of Phase II.

OVERVIEW OF FACILITIES

Facilities for Phase II have been conceptually defined for each of the LA/OMA operating agencies. Development is based upon consideration of the major factors discussed earlier and the unique situation with respect to each agency.

CITY OF LOS ANGELES

Thermal processing of dewatered sludge has been found to be the most feasible alternative for the City of Los Angeles. Such a project is compatible with applicable regulatory requirements and can be implemented within the existing treatment plant boundaries, involves minimal truck traffic, and provides for



resource recovery through production of electricity and steam for use in the processing of wastewaters and sludges. A conceptual diagram of the proposed facilities is contained in Figure V-3.

A mechanical composting demonstration facility will be constructed at the Terminal Island Treatment Plant. One of the two basic systems - batch feeding at wide time intervals or continuous flow fed at short time intervals - will be examined. Process selection will be coordinated with Los Angeles County Sanitation Districts to avoid duplication and to develop the widest possible range of information.

Primary sludge and waste activated sludge (WAS) would be anaerobically digested for gas recovery and organic stabilization. Flexibility for separate or combined digestion would be provided. After digestion the combined sludges would be mechanically dewatered and dehydrated to about 95 percent solids. Studies indicate that dehydration of dewatered sludge can be accomplished using about 400-600 BTU/lb of water to be evaporated.

Following dehydration, sludge (perhaps in pelletized form) would be combusted for further volume reduction and energy recovery. Ash from thermal processing would be trucked to a sanitary landfill for disposal.

Offgases from thermal processing would be combusted and passed through a heat recovery system to produce steam. The resulting steam would be used in a steam turbine to generate electricity and in the dehydration process. Combusted gases would be exhausted to the atmosphere through an air emission cleanup system described in Chapter VI.

If necessary to achieve a net emission increase of 150 pounds/day or less, gas from anaerobic digestion will be cleaned to remove hydrogen sulfide prior to combustion. Gas would be combusted in a combined cycle power plant to produce electricity and steam. Digester gas would also be used in existing internal combustion engines as permitted by air quality constraints and sound engineering principles.

Land availability at Hyperion Treatment Plant is a major constraint on unit process selection. Much of the existing vacant land has been reserved for expansion of wastewater processing capacity and for secondary treatment facilities. Remaining land within the treatment plant boundaries is insufficient to accommodate facilities needed to compost all sludge that is projected to be produced at Hyperion.

Vacant land at the western end of Los Angeles International Airport was considered for location of composting facilities below ground level (subsurface facilities should not interfere with airport operations). However, considerable



uncertainty exists regarding the legally established critical habitat of the El Segundo blue butterfly (*Shijimiaeoides battoides allyni*), an endangered species. The federally proposed critical habitat was withdrawn on March 6, 1979 and there is no precise estimate of a date for final designation of a critical habitat. Comments by the California Department of Fish and Game on the federal proposal stated that a critical habitat designation which corresponds to the present distribution of the butterfly and its larval food plants (a 50-60 acre area in the southern end of the site) should allow for the "normal needs and survival" of this relatively sedentary species if such area were properly protected. Environmental studies indicate that if the area identified for critical habitat were not used for construction of facilities and as much land as possible could be planted in buckwheat (a plant critical to the existence of the butterfly), proposed facilities should not adversely impact the butterfly in view of the fact that the other known habitat is a 2-acre site located in the middle of an oil refinery.

There are reportedly plans to construct a golf course and other recreational facilities in the area removed from the critical habitat as described by the Department of Fish and Game.

While it would appear feasible to locate composting facilities in the area without impacting the endangered species, uncertainty regarding the extent of the legally established critical habitat and the potential conflicts with land use led to the conclusion that composting of all sludge at the Hyperion Treatment Plant would not be feasible in the near term. However, close coordination between City of Los Angeles and the United States Fish and Wildlife Service regarding establishment of the critical habitat for the El Segundo blue butterfly, and close coordination between the Bureau of Engineering and Transportation Departments of the City of Los Angeles regarding plans for use of vacant lands, are needed to assure that due consideration to land needs for wastewater treatment are included in decisions which will emanate from these activities.

Landfill disposal of dewatered sludge is also severely constrained. However, such constraints appear to be political in nature and have led to the conclusion that landfill disposal of sludge by the City of Los Angeles is not feasible. Concerns exist regarding the large volume of truck traffic associated with this alternative.

Phase III Options

Phase III options have been defined for each of the LA/CMA operating agencies from information available at the time of program development. It is recognized that new information may become available during Phase II which could alter the range of options available during Phase III. The Phase III options, however, provide identification of currently indicated long range alternatives. For the City of Los Angeles, the most reasonable Phase III option appears to be expansion of the Phase II dehydration/thermal processing system.

The Phase III option represents an upper limit for sizing of the Phase II facilities. Analysis of the Phase III option provides a description of the maximum potential environmental impact that might be realized if full secondary treatment of wastewaters or other factors necessitate expansion of Phase II facilities capacity beyond that described earlier.

LOS ANGELES COUNTY SANITATION DISTRICTS

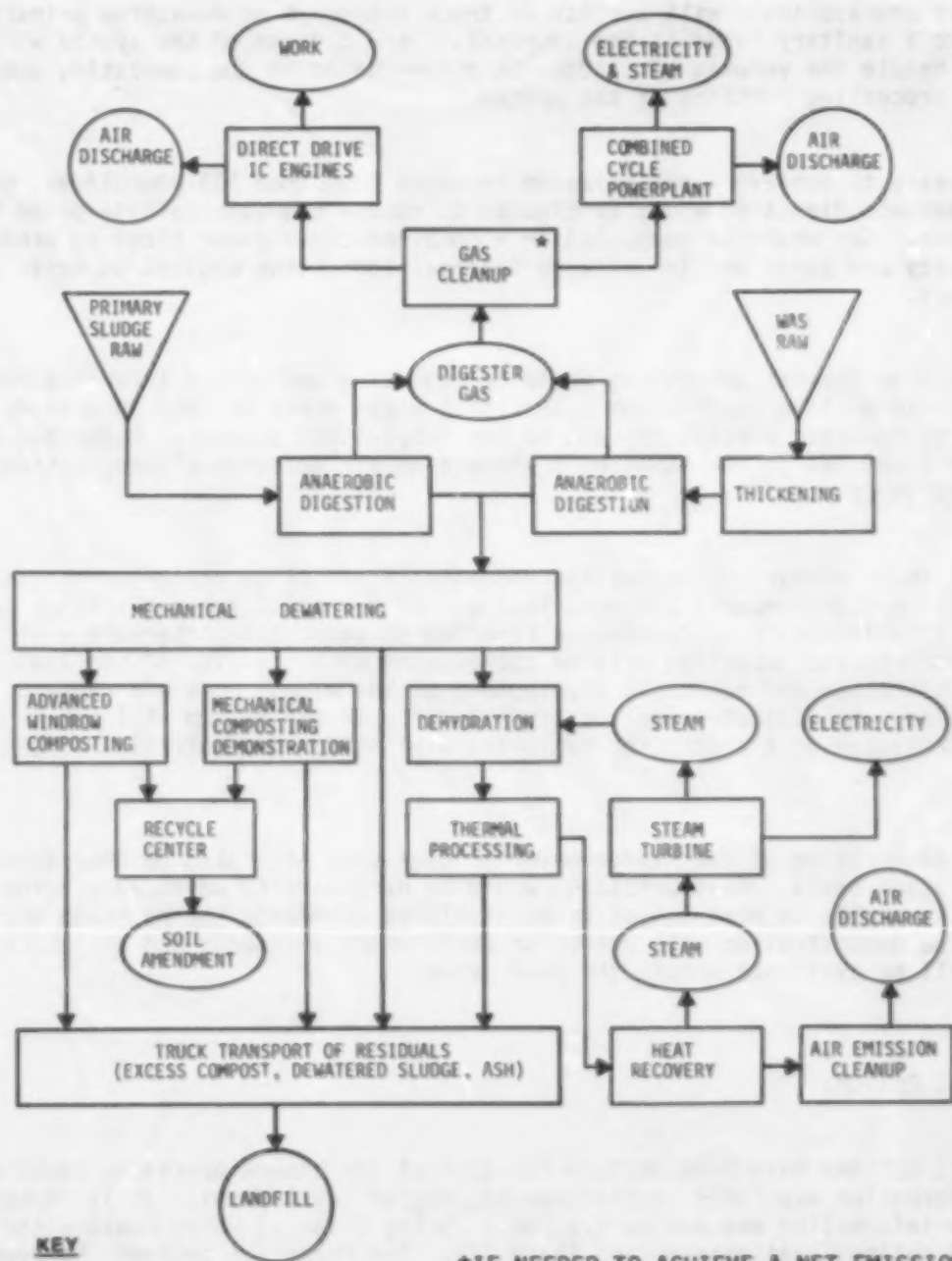
From examination of Figure V-4, it can be seen that all three of the viable alternatives are included in the proposed management program. Primary sludge and waste activated sludge (WAS) would be anaerobically digested for stabilization and gas recovery. Flexibility for separate or combined digestion would be provided. Following digestion the sludges would be mechanically dewatered for subsequent processing.

Following dewatering, three process trains will be used. A fourth - mechanical composting - will be evaluated on a demonstration basis and will not be an integral part of the operating system.

While land availability at the Joint Water Pollution Control Plant (JWPCP) is less of a constraint than at the other LA/OMA treatment plants, sufficient land does not exist for full utilization of the existing windrow composting system. Large amounts of vacant land are being used for construction of secondary treatment facilities. Additionally nuisance problems have been noted with the existing windrow system necessitating improvements if the system is to continue to be used.

The existing windrow composting system will be modified and continued in use for a portion of the sludge. Dewatered primary sludge would be used in the system. WAS could be added if field tests demonstrate that it does not adversely affect the process. Adequate mixing of dewatered sludge and recycled compost prior to placement on the compost field, forced aeration, improved turning devices, and protection from rainfall are among the possibilities to improve throughput and reduce nuisance potential. Composted sludge would be sold for recycle as a soil amendment. Excess compost would be trucked to a landfill.

In the second process train dewatered sludge (primary and WAS) would be dehydrated, (perhaps pelletized), and combusted for volume reduction and energy recovery. Studies indicate that dehydration can be accomplished using about 400-600 BTU/lb of water to be evaporated and is relatively insensitive to slight variations in dewatering performance. Ash from thermal processing would be trucked to a sanitary landfill for disposal.



KEY

- ▽ INPUTS TO THE SYSTEM
- UNIT PROCESSER
- USEFUL PRODUCTS
- END POINTS OF THE SYSTEM

IC - INTERNAL COMBUSTION
WAS - WASTE ACTIVATED SLUDGE

*IF NEEDED TO ACHIEVE A NET EMISSION INCREASE OF 150 LBS/DAY SOX OR LESS.

NOTE: PASTEURIZATION DEMO NOT SHOWN

OVERVIEW OF FACILITIES REQUIREMENTS

LOS ANGELES COUNTY SANITATION DISTRICTS
REGIONAL SLUDGE MANAGEMENT PROGRAM
LOS ANGELES-ORANGE COUNTY METROPOLITAN AREA

FIG. V-4

The third process train will consist of truck transport of dewatered primary sludge to a sanitary landfill for disposal. This portion of the system will be used to handle the volumes of sludge not accommodated in the composting and thermal processing portions of the system.

If necessary to achieve a net emission increase less than 150 pounds/day, gas from anaerobic digestion would be cleaned to remove hydrogen sulfide prior to combustion. Gas would be combusted in a combined cycle power plant to produce electricity and steam and in existing internal combustion engines to drive pumps and motors.

Offgases from thermal processing would be combusted and passed through a heat recovery system to produce steam. Resulting steam would be used in a steam turbine to generate electricity and in the dehydration process. Combusted gases would be exhausted in the atmosphere through an air emission cleanup system described in Chapter VI.

A modest scale mechanical composting demonstration will be conducted to establish full scale design concepts and details. One of two basic systems - batch feeding at wide time intervals or continuous flow fed at short time intervals - will be examined. Process selection will be coordinated with the City of Los Angeles to avoid duplication and to enable development of the widest possible range of information. As indicated earlier, this portion of the system will not be used to manage sludge on a continuing basis and will be for demonstration purposes only.

Heat pasteurization of raw sludge prior to digestion will also be undertaken on a demonstration basis. Pasteurization would be necessary if advanced windrow composting is unable to meet as-yet-to-be developed standards for pathogen destruction. The demonstration will establish performance standards and design criteria which will be available should the need arise.

Phase III Options

Phase III options have been defined for each of the LA/OMA operating agencies from information available at the time of program development. It is recognized that new information may become available during Phase II which could alter the range of options available during Phase III. The Phase III options, however, provide identification of currently indicated long range alternatives. For the Los Angeles County Sanitation Districts, reasonable Phase III options appear to be continuation of Phase II facilities; complete reliance of energy recovery via dehydration/thermal processing; and complete reliance on mechanical composting. Landfilling of dewatered sludge is not considered to be a viable long range alternative. However, an evaluation of landfill disposal will provide information that will be valuable in finalizing the sizing of Phase II facilities.

The Phase III options represent an upper limit for sizing of Phase II facilities and provide flexibility for expansion of composting operations by shifting from the advanced windrow system to an enclosed mechanical system. Analysis of the Phase III options provides a description of the maximum potential environmental impacts that might be realized (1) if full secondary treatment or other factors necessitate expansion of Phase II facilities beyond the loadings described earlier or (2) if, for reasons not known at this time, the sludge processing system must be shifted more heavily to composting or energy recovery.

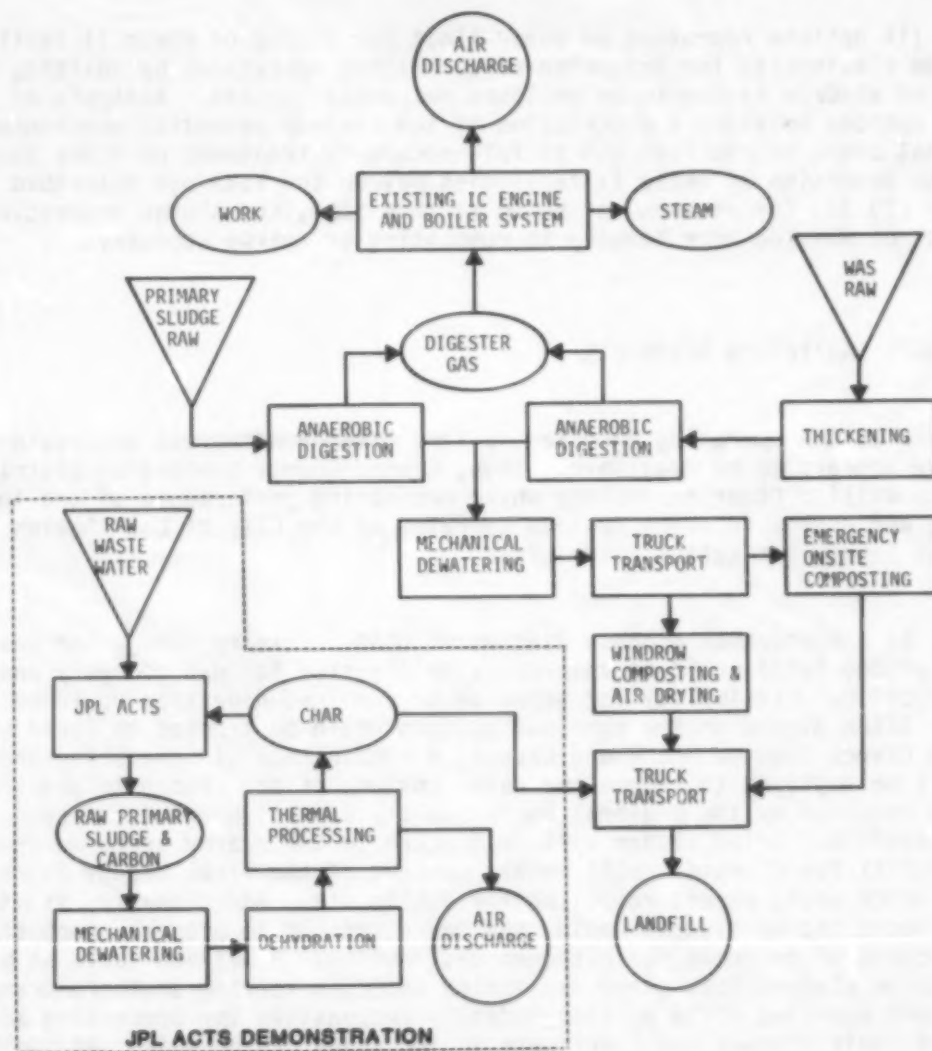
ORANGE COUNTY SANITATION DISTRICTS

Unlike other LA/OMA operating agencies, a land based non-thermal processing alternative appears to be available. Thus, Orange County Sanitation Districts are able to utilize other technology while monitoring performance of the thermal processing and energy recovery systems operated by the City of Los Angeles and Los Angeles County Sanitation Districts.

Figure V-5 is a conceptual process diagram of OCSD. Primary sludge and waste activated sludge (WAS) would be anaerobically digested for gas recovery and volume reduction. Flexibility for separate or combined digestion would be provided. After digestion the combined sludges would be trucked to Round Canyon in eastern Orange County. At Round Canyon, a combination of composting and air drying will be employed to reduce the water content of the sludge to about 50 percent as required by the Regional Water Quality Control Board for disposal in a Class II landfill. Dried sludge will be trucked to the nearby proposed Bee Canyon landfill for disposal until metals content of the final sludge is reduced to levels which would permit recycling for public use. Additionally, if it were to occur, recycling of sludges would then be restricted to properly composted sludges because of concerns for pathogen destruction. Provision could be made to accommodate sludges from other sanitation agencies serving southern Orange County. Such agencies would be independently responsible for processing and handling of their sludges until delivery to the Round Canyon site. At such time as other technology is available, OCSD use of the site will be limited primarily to use as a backup facility.

Within the Joint Works, land availability is greatest at the treatment plant located in Huntington Beach. However, available land is not sufficient to allow for open air composting of all sludge that is to be produced at the Joint Works. Like other LA/OMA operating agencies, vacant land is being reserved for expansion of wastewater processing capacity and for installation of secondary treatment facilities.

Other than anaerobic digestion, all sludge processing will eventually be accomplished at the Huntington Beach Treatment Plant. However, provision is made for an emergency composting system at the Fountain Valley Plant to serve as backup during inclement weather and if truck transport operations are disrupted.



KEY

-  INPUTS TO THE SYSTEM
-  UNIT PROCESSES
-  USEFUL PRODUCTS
-  END POINTS OF THE SYSTEM

IC - INTERNAL COMBUSTION
 WAS - WASTE ACTIVATED SLUDGE
 JPL ACTS - ACTIVATED CARBON TREATMENT SYSTEM

OVERVIEW OF FACILITIES REQUIREMENTS

ORANGE COUNTY SANITATION DISTRICTS

REGIONAL SLUDGE MANAGEMENT PROGRAM
 LOS ANGELES/ORANGE COUNTY METROPOLITAN AREA

FIG. V-5

Both OCSD and EPA have expressed interest in continued development of the JPL-ACTS process which has been pilot tested in a 1 MGD facility at the Huntington Beach Treatment Plant. This process is a potential alternative means for secondary treatment and includes thermal processing of sludge as an integral feature of the total wastewater treatment process. However, in the JPL-ACTS process, the thermal processing step is halted at the point where high carbon content char is produced for use in the wastewater treatment process. In contrast, thermal processing systems proposed for the City of Los Angeles and Los Angeles County Sanitation Districts would carry the combustion process to near completion so that a maximum amount of energy is retrieved from the sludge prior to disposal. Since the JPL-ACTS process, if conclusively proven, could result in lower energy requirements for treatment of wastewaters, it is necessary to compare the overall system (wastewater and sludge) energy efficiency in order to compare JPL-ACTS with the proposed sludge management program. A demonstration facility is proposed to provide reliable information on a large-scale JPL-ACTS system. OCSD is pursuing funding to partially redesign and reactivate the existing 1 MGD JPL-ACTS pilot facility as the first step leading to the large scale demonstration facility. A decision to proceed with the large scale facility could be made pending conclusions from the reactivated pilot study. Since utilization of the JPL-ACTS would be demonstration in nature, provision would be made for handling all sludge at Round Canyon on a continuing basis.

Phase III Options

Phase III options provide identification of currently indicated long-range alternatives. These have been defined from information available at the time of program development. It is recognized that new information may become available during Phase III. On a regional basis, the Phase II facilities that will be constructed by the City of Los Angeles and Los Angeles County Sanitation Districts will provide information for use by OCSD. Additionally, there may be potential for further development of the JPL-ACTS process. For the Orange County Sanitation Districts, reasonable Phase III options appear to be continuation of the Round Canyon composting/air drying facilities, or complete reliance on a thermal processing system such as dehydration/thermal processing for energy recovery or the JPL-ACTS wastewater treatment process.

For purposes of evaluation, the dehydration/thermal processing system defined for the City of Los Angeles (CLA) and L.A. County Sanitation Districts (LACSD) has been assumed. OCSD would utilize information developed by CLA and LACSD during Phase II when considering this option.

The Phase III options represent an upper limit for sizing of the Phase II facilities and provide flexibility for shifting to an energy recovery operation. Analysis of Phase III options provides a description of the maximum potential environmental impacts that might be expected (1) if full secondary treatment of other factors necessitate expansion of Phase II facilities beyond the loadings described earlier, or (2) if the sludge management program shifted to an energy recovery system.

IMPLEMENTATION STRATEGY

The LA/OMA Project Goals Statement adopted in June 1975 calls for development and incorporation of an implementation strategy in the sludge management plan for the Los Angeles/Orange County Metropolitan Area. An implementation program has been developed which describes the actions necessary to carry out the plan, delineates responsibility for such actions, and establishes the time schedule for activities.

The implementation program described addresses completion of Phase I and activities included in Phase II of the sludge management program. Elements of the implementation program are:

- Implementation Schedules
- Facilities Planning and Implementation
- Policy Actions
- Research Studies
- Continuing Planning

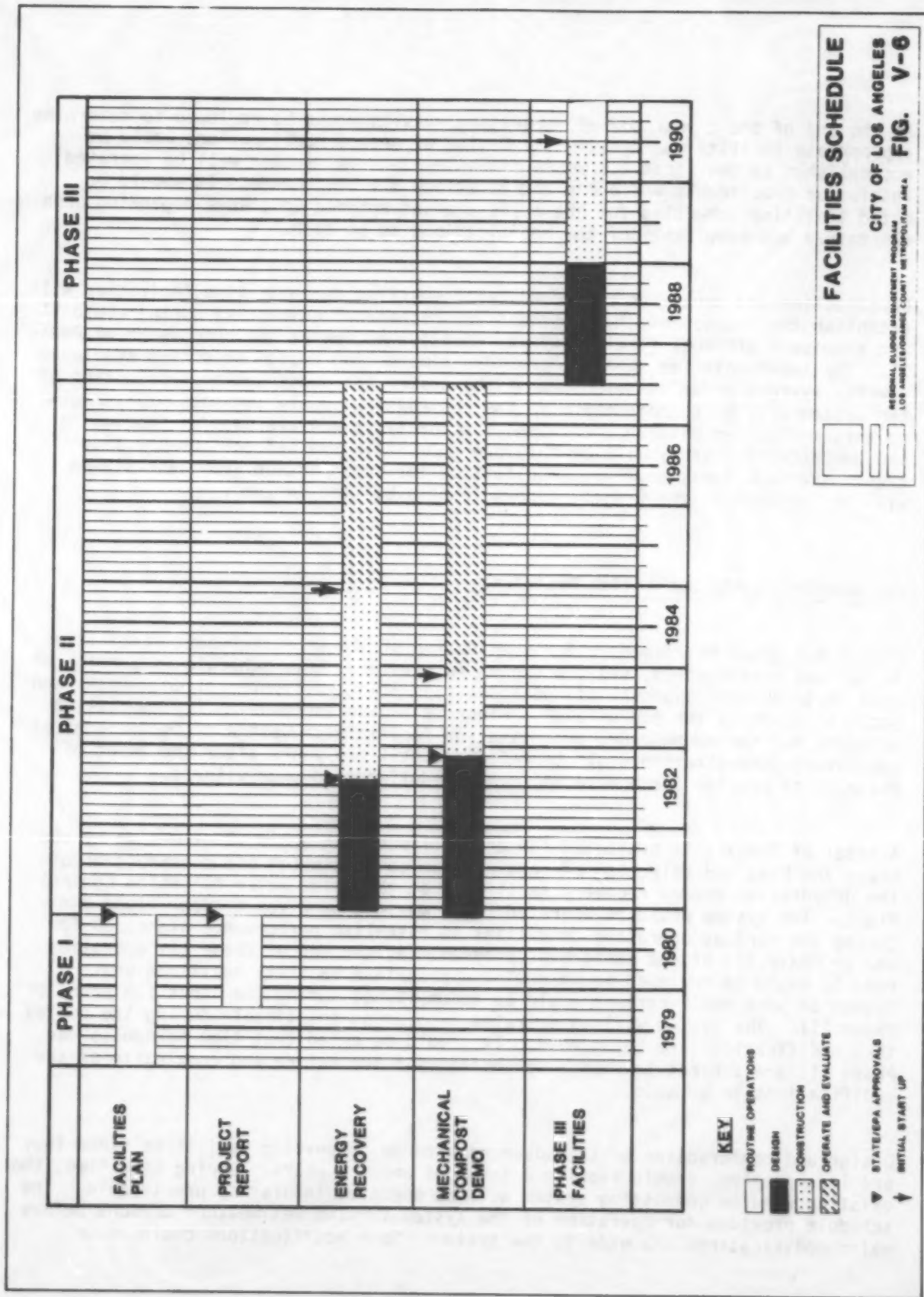
IMPLEMENTATION SCHEDULES

This section describes the time schedules for design and construction of proposed Phase II facilities for each of the operating agencies.

City of Los Angeles

Figure V-6 shows the facilities schedule for the City of Los Angeles. This schedule is predicated upon State and EPA approval of the facilities plan, environmental documents, and project report by the end of 1980.

A total of 5 years is projected for design (including approval by the State and EPA) and selection of construction contractor(s) and construction of dehydration/energy recovery facilities at Hyperion. The system would be operated for a maximum of 2 years under close monitoring and various operating conditions to establish performance standards for use in Phase III of the management program.



At the end of the 2 year period, operating results would be reviewed to determine appropriate facility modifications. Design of needed modifications would be accomplished in the first 1.5 years of Phase III. The system will be operated insofar as practicable while the modifications are being made. It should be noted that time schedules for Phase III are susceptible to change depending upon the nature and complexity of the modifications to be made.

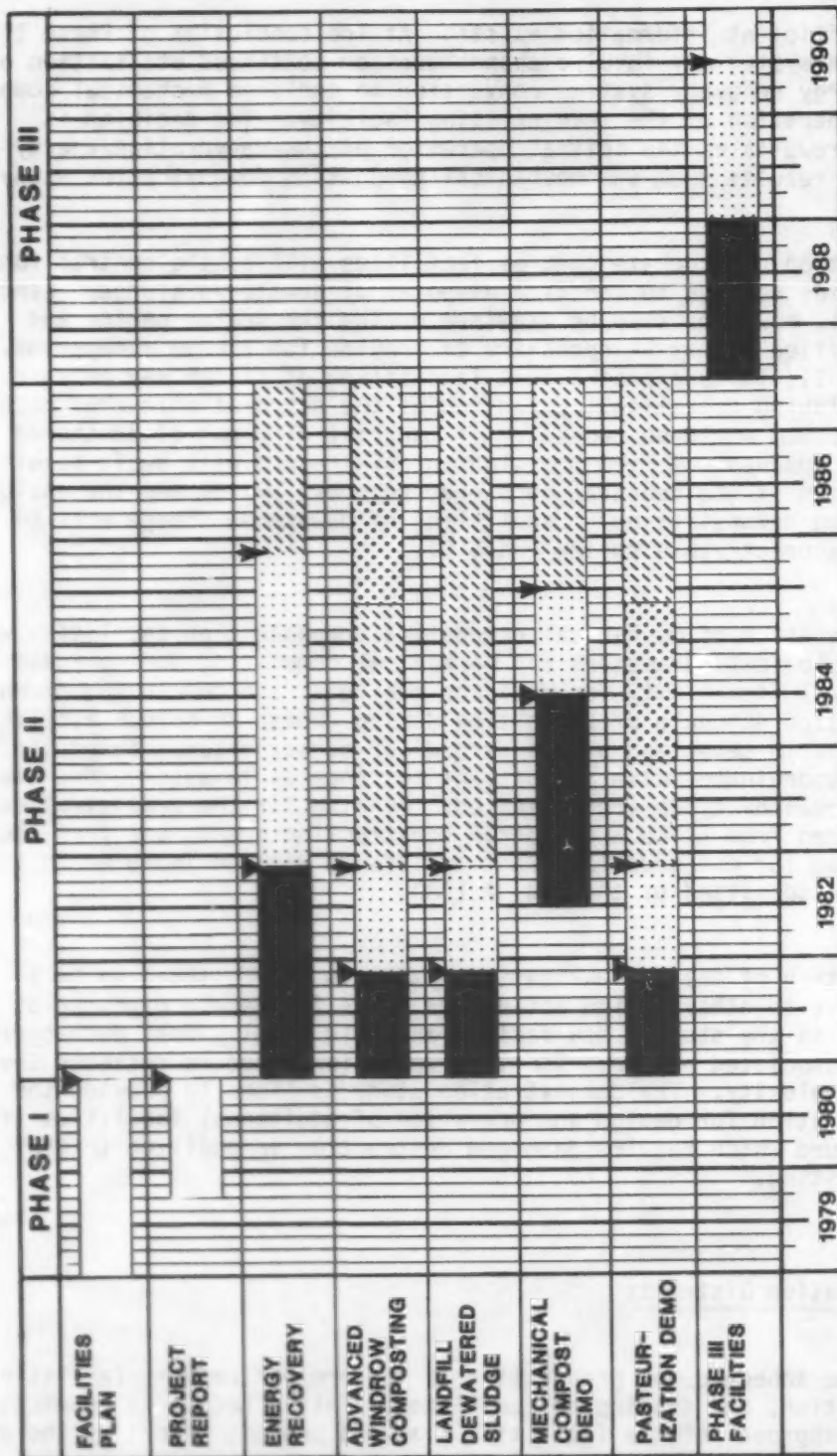
Construction and operation of mechanical composting demonstration facilities will establish the technological parameters for mechanical composting during Phase II and provide additional flexibility for decision making at the conclusion of Phase II. The implementation schedule provides time during design to screen available reactor systems prior to selection of the system for construction. Selection of the system will be coordinated with the Los Angeles County Sanitation Districts to assure that two different enclosed reactor types are evaluated. Funding for the demonstration study will be obtained from State and Federal construction grants and from local sources. Application for construction grant assistance will be included in the project report to be submitted in 1980.

Los Angeles County Sanitation Districts

Figure V-7 shows the schedule for preparation of the project report, facilities design and construction, and startup of facilities. This schedule is predicated upon State and EPA approval of the facilities plan, environmental documents, and project report by the end of 1980. Figure V-7 also includes an implementation schedule for the recommended demonstration facilities. Design of the mechanical composting demonstration would be deferred until two years after the onset of Phase II to provide for a more uniform scheduling of design efforts.

A total of 5 years is projected for design (including approval of design by the State and EPA) and selection of construction contractor(s) and construction of the dehydration/energy recovery facilities at the Joint Water Pollution Control Plant. The system would be operated for a maximum of 2 years under close monitoring and various operating conditions to establish performance standards for use in Phase III of the management program. At the end of Phase II, operating results would be reviewed to determine appropriate facility modifications. Design of such modifications would be accomplished during the first 1.5 years of Phase III. The system will be operated insofar as practicable during the period that modifications are being made. It should be noted that time schedules for Phase III are subject to change depending upon the nature and complexity of the modifications to be made.

Design and construction of the advanced windrow composting facilities since they are less complex, should require a total of about 2 years. During this time, the existing windrow composting system will be operated insofar as practicable. The schedule provides for operation of the system for two wet weather seasons before major modifications are made to the system. Such modifications could occur



KEY

- ROUTINE OPERATIONS
- DESIGN
- CONSTRUCTION
- OPERATE AND EVALUATE
- DESIGN AND CONSTRUCT MODIFICATIONS
- STATE/EPA APPROVALS
- INITIAL START UP

FACILITIES SCHEDULE

LOS ANGELES COUNTY SANITATION DISTRICTS

REGIONAL SLUDGE MANAGEMENT PROGRAM

LOS ANGELES/ORANGE COUNTY METROPOLITAN AREA

FIG. V-7

earlier provided sufficient information exists. At the conclusion of Phase II, modifications to the system may involve abandonment or continued utilization of the dehydration/energy recovery system, conversion to enclosed mechanical composting, or continued operation of the then existing facility. The decision is dependent upon the results of the initial operation of the dehydration/energy recovery system and results from the mechanical composting demonstration study.

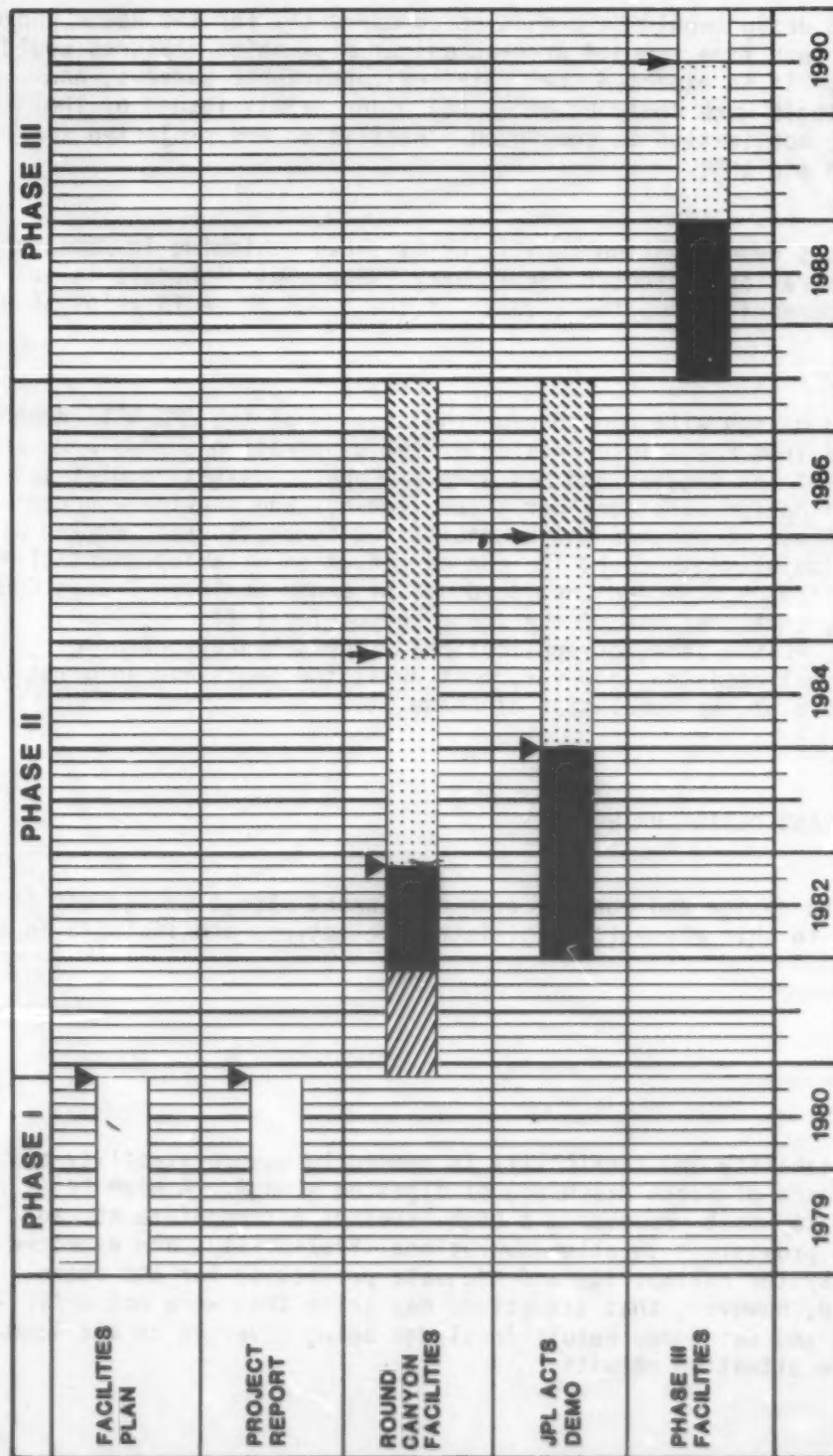
Design and construction of leachate control facilities will be the central focus of Phase II activities related to landfill disposal of dewatered sludge. Landfill operations will, however, also be examined during the design period and modifications identified as may be necessary to provide for sludge management. At the end of Phase II, it is expected that landfilling of sludge may be sharply curtailed as a continuing operation. Expansion of the dehydration/energy recovery or composting system would be necessary if landfill disposal of dewatered sludge were to be abandoned. A firm decision in this regard will await results from initial operation of the dehydration/energy recovery system and the enclosed mechanical composting demonstration. Landfilling of dewatered sludge will be continued insofar as practicable during Phase II.

Construction and operation of mechanical composting demonstration facilities will establish the technological parameters for mechanical composting during Phase II and provide additional flexibility for decision-making at the conclusion of Phase II. The implementation schedule provides time during design to screen available reactor systems prior to selection of the system for construction. Selection of the system will be coordinated with the City of Los Angeles to assure that two different enclosed reactor types are evaluated. Funding for the demonstration study will be obtained from State and Federal construction grants and from local sources. Application for construction grant assistance will be included in the project report to be submitted by the end of 1980.

Design and construction of the pasteurization system is not believed to be a complex task relative to other design activities. One full scale digester at JWPCP would be used in the study. New facilities would involve heat exchangers, contact tank, and associated piping. The implementation schedule reflects the reduced level of complexity. The demonstration study is timed to provide the technological information for design and operation of additional facilities if regulations are issued which require pathogen destruction in addition to that achievable by composting.

Orange County Sanitation Districts

Figure V-8 shows the schedule for preparation of the project report, facilities design and construction, and startup of facilities. This schedule is predicated upon State and EPA approval of the facilities plan and project report by the end of 1980.



KEY

- ROUTINE OPERATIONS
- SITE ACQUISITION
- DESIGN
- CONSTRUCTION
- OPERATE AND EVALUATE
- STATE/SEPA APPROVALS
- INITIAL START UP

FACILITIES SCHEDULE
 ORANGE COUNTY SANITATION DISTRICTS
 REGIONAL BLUDGE MANAGEMENT PROGRAM
 LOS ANGELES/ORANGE COUNTY METROPOLITAN AREA
FIG. V-8

Site acquisition and design would be conducted concurrently for the Round Canyon facilities. During such time, needed archaeological mitigation measures would also be implemented. It is expected that detailed topographic surveys, and engineering and geologic work could be conducted under permit issued by the landowner until site acquisition is completed. Facilities are projected for initial operation in mid 1984.

Design of the JPL-ACTS demonstration facilities is shown beginning in January 1982 with initial operation projected for January 1986. This schedule is susceptible to change depending upon the results of the 1 MGD JPL-ACTS pilot study by OCSD.

Phase III facilities design will depend upon the results of the JPL-ACTS demonstration and results from Phase II operation of the dehydration/energy recovery systems by the City of Los Angeles and Los Angeles County Sanitation Districts. Phase III facilities design will consider these findings and provide appropriate adjustments to the Phase II program which consists of composting/air drying at Round Canyon. Such adjustments could include continuation or abandonment of the Round Canyon facilities by OCSD and continued use by other Southern Orange County Sanitation agencies, continued use of the Round Canyon facilities by OCSD, expansion of the JPL-ACTS system, or application of the dehydration/energy recovery system. Final decision, however, must await the facts and information that will be available at the conclusion of Phase II.

FACILITIES PLANNING AND DESIGN PRINCIPLES

Activities related to design and construction of planned sludge management facilities are presented in this element. Administrative actions are included in the discussion.

System Reliability

A high level of reliability and flexibility is needed to assure stability of operation and avoidance of ocean discharge of digested sludge. A high level of standby capacity in key unit processes, a high level of intermediate storage, a conservative design provisions to allow operational flexibility, are expected to provide reasonable system reliability and adequate protection for the ocean. It should be recognized, however, that situations may arise that were not anticipated during design and which may result in sludge being diverted to the land-fill or ocean as the situation permits.

Air Emission Controls

Control of air emissions is a key factor in the acceptability of facilities proposed for the City of Los Angeles and Los Angeles County Sanitation Districts. Provisions have been made for what is believed to be reliable emission control technology at these facilities. In the case of Orange County Sanitation Districts, new or modified combustion facilities are not proposed and it is therefore assumed that existing facilities are meeting existing permit requirements. Thus, except as indicated, the following discussion is applicable to facilities proposed for the City of Los Angeles and Los Angeles County Sanitation Districts.

If necessary to achieve net emission increases of 150 pounds per day or less, hydrogen sulfide will be removed from digester gas prior to combustion at the City of Los Angeles and Los Angeles County Sanitation Districts. At Orange County Sanitation Districts, similar provision has not been made since such gas is to be used in existing internal combustion engines and full scale thermal processing is not proposed. Although it may be desirable from strictly an air quality standpoint, it should be kept in mind that cleaning of digester gas considers only the removal of hydrogen sulfide. Use of such gas in the internal combustion engine produces prodigious amount of other pollutants, particularly hydrocarbons, oxides of nitrogen, and carbon monoxide. Prospects for control center principally around catalytic controls on the exhaust gases. However, there is some question regarding the economic viability of the process particularly with regard to the catalyst life.

Particulate emissions control from thermal processing offgases will be accomplished after heat recovery. A fabric filter has been identified for purposes of project evaluation because of the relative simplicity of design, a high level of efficiency in the capture of sub-micron size particles, and preliminary indications that such systems are becoming a standard of practice. Electrostatic precipitators also achieve high efficiency of total particulate removal and high efficiency of sub-micron particle capture and as such may also be considered during facilities design. However, because of the importance of capture of sub-micron particles to the control of metals emission, use of high energy venturi systems does not appear appropriate. Additionally, such systems require substantial amounts of energy.

Wet chemical scrubbing facilities have been assumed for removal of sulfur dioxide from the thermal processing exhaust gases. Such controls are the major system currently in use for flue gas desulfurization. Other alternatives currently in the developmental stage involve lime addition to feed material prior to combustion. As such controls become available prior to design commitments, they may be considered.

Control of emissions of oxide of nitrogen can be accomplished by at least two means - (1) conversion from internal combustion engines to use of combined cycle systems and (2) through application of air emission controls to the offgases from thermal processing.

Use of gas turbines in the combined cycle system provides for efficient combustion of the digester gas without excessive emissions of hydrocarbons, oxides of nitrogen, and carbon monoxide that are associated with the internal combustion engines. Such emissions are low because of the nature of the combustion that occurs in the turbine. Further reductions in emissions of oxides of nitrogen may be possible through incorporation of water injection into the turbine; however, such decision should await design of the facilities.

Two basic control systems are available for reduction of NO_x emissions from the thermal processing system. Selective catalytic reduction systems employ a catalyst which interacts with the exhaust gases and reportedly can achieve 90 percent efficiency of removal. However, there are substantial questions regarding poisoning of the catalyst by particulates and sulfur dioxide, both of which are present in exhaust gases from the thermal processing system. Until such uncertainties are resolved, it is not possible to establish with certainty the life of the catalyst. Since the catalyst in such systems is expensive, the economic implications of uncertain catalyst life are obvious.

Non-catalytic systems are, however, available and appear to be fairly well proven. Such systems provide for injection of ammonia into the flue gas whereby oxides of nitrogen are converted to elemental nitrogen. Selective non-catalytic reduction is reportedly capable of achieving removal efficiencies of 50 percent or greater, has the advantage of simplicity and avoids problems associated with use of a catalyst.

Finally, since zero emission is not practically achievable, a stack dispersal system will be employed as the last step in the air emission cleanup system. The stack will include provision for plume suppression and should avoid new violations of ambient air standards at ground level.

It should also be noted that the foregoing discussion is intended to establish the feasibility in a descriptive fashion of the air cleanup system. During design of the system, the air cleanup system will be thoroughly reevaluated. As such, final selection of unit processes will be made at that time.

Regulations of the South Coast Air Quality Management District indicate that stationary source curtailment plans will be required for facilities involving thermal processing of sludge. Such plans are intended to reduce emissions of air pollutants at times when ambient air quality is degraded to levels which could endanger or cause significant harm to public health.

Stationary source curtailment plans will be prepared during design of sludge management facilities. Such plans should not call for curtailment of electrical generation facilities using digester gas since such facilities utilize a clean fuel (digester gas) and provide power to operate the wastewater treatment plant. Similarly, internal combustion engines which are used to drive pumps and motors

as an integral part of the wastewater treatment plant will not be curtailed. Thus, stationary source curtailment plans should involve only the curtailment of thermal processing operations.

Analysis indicates that curtailment of thermal processing operations would be significantly effective only with respect to reductions in emission of sulfur dioxide. Accordingly, stationary source curtailment plans should include curtailment of thermal processing operations only during sulfur dioxide and/or sulfate episodes.

In view of the lack of regional significance of the emissions from the thermal processing equipment, the essential nature of the sludge management program, and in view of the fact that other sources in the basin are large and would appear to offer more efficient opportunities for emission reductions, thermal processing systems would not be curtailed during a Stage I alert. During a Stage II alert for a sulfur dioxide and/or sulfate episode, thermal processing would be curtailed and operated only to provide steam to the dehydration unit. Dehydrated sludge would be stored or trucked to a landfill until the air quality episode is terminated. If such curtailment is insufficient to meet air quality needs, the dehydration and thermal processing operations would be curtailed entirely. Sludge in excess of the capacity for storage or processing in other parts of the system would be discharged to the ocean via existing outfall systems.

Nuisance Controls

Additional information relating to odor, dust, noise, and other nuisance concerns for the Phase II facilities is contained in the following discussion. The information is applicable to each LA/OMA operating agency as indicated by the respective Phase II facilities requirements.

WAS Thickening: DAF thickening occurs in open basins and has the same character and intensity of odor as activated sludge aeration basins, a "moist earth" smell. To control this odor, covers will be installed or the open basins will be housed in a building. In either case, ventilation, deodorization, and/or dispersion could be provided sufficient to eliminate perceived odors beyond 50 to 100 feet from the facility. The major noise source would be the air compression equipment. This noise would be audible just outside the building housing the equipment, but design provisions could be included to contain such noise within the treatment plant boundaries.

Other processes can be used for WAS thickening. Usually these involve polymer addition followed by either centrifugal or filtration dewatering. It has been assumed that such facilities would be housed in a building. Noise and odor concerns should be no greater than those associated with DAF thickening.

Anaerobic Digestion: Anaerobic digestion occurs in sealed reactors. During normal operation little or no odor should occur. Odors can occur during digester cleaning which is an intermittent operation. Odors have also been observed as a result of cracks in the concrete structure of the reactor. Adequate maintenance will be conducted to eliminate and avoid digester cracks. Anaerobic digestion should not be a significant odor source under these conditions. Noise sources would be compressors and pumps for the mixing-heating system. Design provisions could be included to contain such noise within the treatment plant boundaries.

Combined Cycle Power Plant: There should be no odor with the combined cycle plant itself. Digester gas cleaning to remove H_2S , may carry an odor potential depending on the type of scrubbing employed. If high pressure water scrubbing is used, a liquid sidestream would be produced, which contains dissolved H_2S . Such sidestreams should not be exposed to the atmosphere, but blended with plant effluent and dispersed in the ocean outfall system.

There would be a moderate amount of noise directly overhead the combined cycle plant, but if a stack were to be used, and the facility enclosed in a building, such noise should be inaudible at outside ground level. As a matter of example, a 120 foot stack would add about 20 percent to the installed capital cost.

Liquid Sludge Storage: Liquid sludge storage facilities should be similar in design to anaerobic digesters. Therefore, odor and noise concerns would be no greater than those associated with anaerobic digestion.

Mechanical Dewatering: Centrifuges (LACSD and CLA) and belt presses (OCSD) are the likely dewatering alternatives for the operating agencies. Odors can occur from the dewatering devices and conveyer belt or screw conveyer systems used to transport the dewatered cake. Therefore, dewatering facilities should be located within buildings. Building air should be ventilated, deodorized and/or dispersed so that little or no odor should be perceived outside the structure. Building design should provide for containment of noise within treatment plant boundaries.

Dewatered Sludge Storage: Wet cake will be stored in enclosed bin structures similar to that presently used at JWPCP. Significant odors can potentially be emitted from the sludge resulting in high odor levels in the enclosed structure at the top of the bins. Air from the building should be collected, deodorized, and dispersed. Given the relatively high elevation of the structure, the dispersed air should result in little or no ground level odor. Building design should provide for containment of noise within treatment plant boundaries.

Dehydration: Potential odor sources include the fluidizing oil storage facilities, vacuum pump exhaust, conveyance facilities for deoiled and hydro-extracted cake, and dried product storage system. Storage and conveyance facilities should be enclosed and maintained under slight vacuum to assure collection of all vapors and odors. Vacuum pump exhaust should also be collected. Condensed oil should be removed and all collected gases used as combustion air in the thermal process. This would result in complete destruction of all odorous vapors. Also, use of Isopar (a fractionated isoparaffinic hydrocarbon) or other petroleum products can be expected to minimize odor potential.

Potential noise sources include the recirculating pumps, vacuum pumps, and fluid circulation in heat exchangers and vapor chambers. The entire facility should be housed within a building. Building design should provide for containment of noise within the treatment plant boundaries.

Thermal Processing: Thermal processing has traditionally produced odors if exhaust gas temperatures are less than 800 to 1200°F; if fuel gas is condensed to form liquid byproducts; or if significant organic matter remains in the char/ash product. For the thermal processes considered by LA/OMA, fuel gas produced would be immediately combusted to eliminate any odor potential. Minimum after-burner temperatures of 1400°F should be maintained. Char/ash should be processed in enclosed equipment to the maximum extent possible with vent gases used as combustion air in the furnace. With these design provisions, there should be essentially no odors outside the thermal processing building.

Potential noise sources include the forced and induced draft fans and air cleanup scrubbers. Building design should provide for containment of noise within the treatment plant boundaries.

Truck Transport: Trucks will be used to transport a number of residuals from the treatment plants to landfill sites for ultimate disposal. These residuals include dewatered cake, char/ash, digester cleanings, residue from air cleanup trains and perhaps compost on a periodic basis. Trucks used for transport of wet sludge should have sealed beds to prevent leakage of material. Trucks used to transport material which may be dusty in nature, such as char/ash, should be covered to reduce nuisances. For JWPCP and OCSD where dewatered cake will be routinely transported, truck washing facilities should be provided at the treatment plant to reduce the potential for deposition of material on surface streets.

Odor production from truck transport would be comparable to the present operations at JWPCP and OCSD which are not significant sources of odors. Trucks should be muffled to conform with applicable decibel limitations.

Advanced Windrow Composting: The windrow composting facility in use at JWPCP has in the past been a significant nuisance source. Improvements included in the Phase II facilities are directed towards minimization of nuisance potential. Additionally, operational procedures should be established to minimize nuisance potential associated with materials handling. It is difficult, however, to define specific design conditions since the process is subject to climatic effects and information on micro-climatic conditions in the vicinity of the treatment plants is lacking. If the improvement is not sufficient to meet local community requirements, and if additional mitigation measures are not available, the alternative would be to install an enclosed compost system (provided the feasibility of enclosed composting is proven during pilot demonstrations) or abandon the process in favor of other alternatives.

Noise sources associated with the windrow compost operation are primarily due to mobile equipment which should be muffled to conform to applicable decibel limitations.

Mechanical Composting: One of the advantages of enclosed composting is increased control over odor and dust nuisances. It is entirely possible to construct an enclosed system for both the composting and drying phases so that sludge is not exposed to ambient conditions. All air used in the composting and drying operation can be collected, treated, and dispersed via a stack to reduce ground level impacts. One purpose of the demonstration system is to determine whether such strict environmental controls are necessary. Therefore, the demonstration system can be expected to function in several operating modes. In any case, dusts, odors and noise would be greatly reduced compared to the present windrow operation and should have minimal impact beyond the plant boundary.

Recycle Center: The present sludge recycle center operated at JWPCP may have been a source of odor and dusts in the immediate vicinity of the recycle center. Several possibilities for improving this operation have been outlined in the Phase II facility descriptions. If implemented, these should reduce the odor and dust potential and improve the aesthetic attractiveness of the facility.

Materials handling equipment and truck traffic are the only significant noise sources, but these are operated only during normal business hours.

Landfill Disposal: Landfill disposal operations should be conducted in accordance with operational practices now in use at the existing landfills. Concern has been expressed that sludge moisture may accelerate refuse decomposition resulting in additional odorous landfill gas to be managed.

Additional Control Measures

Concern for nuisance potential has played an important role in development of the proposed sludge management program. This is in keeping with the operating agencies' concern over odor. Established and proven design philosophies used by the local agencies, such as enclosure of process equipment and deodorization of collected air streams, are reflected in the Phase II facility descriptions which follow in Chapter VI. Nevertheless, design for odor control is not an exact science and it is often difficult to predict the extent of odor control measures required to avoid nuisance conditions. Should any proposed Phase II facilities exceed the expected odor emissions, a number of design modifications are available for application. These include but are not necessarily limited to (1) additional coverage and venting of highly odorous sources; (2) better deodorization and/or dispersal of collected gases by taller stacks; (3) vacuum vaporization of liquid digested sludge; (4) use of blending digesters to reduce odor peaks; (5) installation of odor barriers such as walls which also increase ground level dispersion; and (6) use of wind machines to increase ground level mixing during periods of stable air flow.

All of these measures may not be applicable to a given situation. Means are, therefore, available to reduce odor impacts if the the present conceptual design should prove to be inadequate. The same is true for nuisances such as noise and dust. Additional soundproofing of stationary noise sources is usually possible if the initial design proves inadequate. All mobile equipment should be properly muffled and will conform to applicable decibel limits. Dust control measures have been included in the recommended Phase II facilities, but additional mitigation measures may be developed as a result of demonstration projects. For example, pelletizing of the finished compost may prove to be an effective dust control measure which could eventually be implemented.

Building Heights

Until final design is completed, only a general description of building heights can be provided. The following building heights have been assumed for purposes of evaluation: Carver-Greenfield process, 80 feet (except at Hyperion where 60 feet has been assumed because of ability to construct below ground surface); thermal process, 80 feet (except at Hyperion where 60 feet has been assumed); dewatering, 40 feet (60 feet at Hyperion since the existing dewatering building will be converted); mechanical compost building, 30 feet; possible storage enclosures in recycle center, 40 feet. Major structures should be similar in architectural quality to existing buildings.

ADMINISTRATIVE ACTIONS

Executive decisions are required to enable design, construction, and operation of planned facilities to proceed. Such decisions relate principally to providing additional facilities planning details, acquisition of needed regulatory approvals, and execution of agreements which are required by the program.

Project Reports

Each operating agency will prepare a project report which supplements the facilities plan. The project report will focus on presentation of detailed information needed for design of planned facilities, generic identification of equipment, and other such detailed design requirements. Each project report will also include a detailed implementation schedule which includes description and timing of the design program, means for operator recruitment and training, permit acquisitions, financial plan and other such actions necessary to full implementation of the facilities plan. The Project report will also include any applications for State/EPA construction grant assistance for demonstration facilities.

Permit Acquisition

Each operating agency will be responsible for obtaining permits required for construction and operation of planned facilities. It is anticipated that permits to construct facilities would be obtained as early as practicable during the design phase. To the extent possible, permits to operate would be obtained within the same time frame. Major permit needs and regulatory compatibility are discussed in Chapter VII.

Operator Recruitment

Each operating agency will assure that trained operators are available at the time of initial startup of facilities through a combination of training and recruitment programs. The project report will describe the recruitment and training program and present the required minimum qualifications for each class of operator.

Contractual Arrangements

Contractual arrangements for marketing sludge derived products should be finalized by the time of initial operation of facilities. Where such arrangements

exist, such contracts will be continued until the specified expiration date. Otherwise, contractual arrangements will be developed in accordance with procedures and requirements of the respective operating agencies.

POLICY ACTIONS

This element describes actions which require policy decisions for implementation of certain features of the proposed management program.

Air Quality

The City of Los Angeles and Los Angeles County Sanitation Districts will assist in implementation of the provisions of AB 524 (Calvo). To this end each agency, to the extent that emission offsets are not provided by the proposed sludge management program, will make a good faith effort to secure emission offsets needed to comply with applicable new source review requirements. By June 30, 1980, the Air Resources Board (ARB) will be advised of the proposed construction of facilities to recover energy resources from sludge as described in the proposed management program.

Notification of the Air Resources Board of the construction of the proposed sludge management facilities should assure that such facilities are included in the ARB inventory of resource recovery projects that are planned for construction before 1987. AB 524 (Calvo) requires the Air Resources Board to prepare revisions to the State Implementation Plan which would provide for necessary mitigation of the air quality impacts of resource recovery projects included in the aforementioned inventory.

The City of Los Angeles and Los Angeles County Sanitation Districts will work with the South Coast Air Quality Management District (SCAQMD) to develop:

- practicable measures for control of air emissions found to be in excess of emissions projections contained in approved applications to construct Phase II facilities, and
- information on the need for and availability of regional emission offsets that may be required for operation of Phase II and Phase III facilities.

The foregoing information will be considered in decisions made at the conclusion of Phase II and close coordination of sludge management and air quality management programs will be achieved. Additionally, this process will result in

appropriate revisions to the Air Quality Management Plan (AQMP) for the South Coast Air Quality Management Plan so that the purposes and requirements of AB 524 (Calvo) may be realized.

The Environmental Protection Agency and the State of California acting through the Water Resources Control Board will provide leadership and assistance necessary to realize fruition of the foregoing actions. During Phase II, EPA will exercise its authority under Section 316 of the Clean Air Act to assure that direct and indirect emissions from planned sludge management facilities are identified in the State Implementation Plan (SIP) and to assure that schedules of reasonable further progress set forth in the SIP are consistent with sludge management needs. The State Water Resources Control Board will cooperate with the Air Resources Board and the local operating agencies in the implementation of the provisions of Assembly Bill 524-Calvo.

Industrial Source Control

The City of Los Angeles, Los Angeles County Sanitation Districts, and Orange County Sanitation Districts will continue aggressive implementation of industrial source control programs. Such programs will be geared toward attainment of sludge quality consistent with public health and environmental requirements associated with the proposed sludge management plan. Each of the agencies should periodically, (probably no more than once every two years) review with the Regional Water Quality Control Board, Air Quality Management District, and EPA, the effectiveness of industrial source controls to determine if modifications are necessary.

EPA should review existing and projected sludge characteristics after application of industrial source control measures to identify those undesirable substances which, after application of industrial source control requirements, continue to be of concern with respect to human health or environmental effects. EPA should establish the feasibility for elimination of such substances from general use in society and, where cost effectiveness is indicated, establish a time schedule for such elimination.

Public Participation

Review of the LA/OMA Project experience and the experience of the Los Angeles County Sanitation Districts indicates that active citizen involvement has good potential for enhancing the understanding of problems facing the operating agencies. Establishment of appropriate citizens advisory groups to work with the operating agencies during design and construction of sludge management facilities should be undertaken to aid the agencies in consideration of means to minimize nuisance potential and assist in enhancement of neighborhood understanding.

RESEARCH NEEDS

Research needs have been identified during the course of development of the sludge management program which are important to provide additional flexibility for decision making at the conclusion of Phase II. The identified studies will fill existing gaps in knowledge and thus provide for consideration of a wider range of alternatives in selection of Phase III facilities.

- Expanded research and development is needed to enhance the potential for using sanitary landfill as an energy source. Gas recovery and cleanup technology improvements, and examination of potential for enhancement of gas production by addition of sludge and liquids are areas of needed study. Control of potential for nuisance conditions and development of sound operational procedures are also in need of development.
- Detailed monitoring of the operation of Phase II facilities should be conducted by operating agencies. Such study would ensure the availability of adequate environmental, engineering, and economic data at the end of Phase II and enhance the ability for decisions regarding facilities expansion, replacement, or deletion.
- Further examination of the environmental consequences of low levels of toxicant emissions associated with composting, thermal processing, and ocean disposal is needed to improve definition of the various risks involved and to provide flexibility for consideration of alternatives at the conclusion of Phase II.
- Opportunities for segregation of sludges within the total sewerage system to reduce the metals content of sludges intended for reuse should be examined. Conclusions regarding the potential cost effectiveness of such opportunities should be developed.
- The efficiency of pretreatment programs in maintaining sludge quality should be monitored and a correlation between pretreatment control actions and sludge quality established by each of the operating agencies.
- Nonsewered liquid waste disposal activities should be examined on a regional basis and programs developed so that landfill disposal of dewatered sludge does not result in problems of liquid waste disposal. Such work should build upon the LA/OMA Nonsewerable Waste Study and include refinement and expansion of the information provided by the study. Identification and evaluation of alternatives and establishment of a liquid waste management program in coordination with sludge management programs should be the principal goals of the regional study.

CONTINUING PLANNING

The proposed sludge management program fulfills requirements of the 208 planning process relative to sludge management by the City of Los Angeles, Los Angeles County Sanitation Districts, and Orange County Sanitation Districts. Development of the program is specified in the 208 plan for the South Coast Planning Area.

Since sludge management is an integral part of wastewater treatment, responsibility for plan update will be the responsibility of the individual operating agencies - City of Los Angeles, Los Angeles County Sanitation Districts, and Orange County Sanitation Districts. Such planning will be coordinated with areawide waste treatment management planning and solid waste management planning conducted by the Southern California Association of Governments.

CHAPTER

VI

CHAPTER I

**BACKGROUND AND
PROBLEM DESCRIPTION**

CHAPTER II

**DEVELOPMENT OF THE
ALTERNATIVE SLUDGE
MANAGEMENT PROJECTS**

CHAPTER III

**DESCRIPTION OF THE
ALTERNATIVE SLUDGE
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CHAPTER IV

**COMPARATIVE EVALUATION
OF THE SLUDGE
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CHAPTER VI

**DETAILED PHASE II
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CHAPTER VII

ANALYSIS OF KEY TOPICS

APPENDICES**CHAPTER VI****DETAILED PHASE II FACILITY
DESCRIPTIONS**

- **FACILITIES FOR CITY OF
LOS ANGELES**
- **FACILITIES FOR LOS ANGELES
COUNTY SANITATION DISTRICTS**
- **FACILITIES FOR ORANGE COUNTY
SANITATION DISTRICTS**

DETAILED PHASE II FACILITY DESCRIPTIONS

Detailed descriptions of the proposed Phase II facilities are required (1) to avoid delays in starting the design phase, (Step II), of plan implementation; (2) to fulfill requirements for the facilities plan document; and (3) to allow preparation of the EIR/EIS on the recommended facilities. Numerous meetings and discussions were held with the participating agencies and further engineering evaluation conducted. Purpose of this chapter is to present detailed descriptions of the Phase II facilities proposed for the City of Los Angeles, Los Angeles County Sanitation Districts, and Orange County Sanitation Districts.

During development of the facilities plan, information used in the quantitative assessment was periodically updated to reflect current data. The economic analysis of Phase II facilities was adjusted to a current timeframe. Changes were made in capital and O & M cost factors used in the economic analysis as shown in Table VI-1. All O & M cost factors were increased to reflect conditions as of summer, 1979. The ENR Construction Cost index was increased to 3500 from the value of 3031 used in the economic evaluation presented in Chapter IV. In addition to the cost factor changes, certain other unit processes, such as intermediate storage, were added to the treatment trains. The inclusion of such processes was possible, because of the more detailed nature of the Phase II facility descriptions. The majority of these additions would have been common to all sludge management projects and would not have influenced selection of the conceptual plan. Finally, design efforts on the part of the operating agencies had progressed to where certain sludge related facilities were already committed for construction. Costs for these facilities were assumed to be expended and were not included in Phase II costs unless otherwise noted. As a result of these changes, the economic analysis of the Phase II facilities is not directly comparable to that presented in Chapter IV for the alternative sludge management projects.

Minor changes were also made in the manner of digester gas use. In all previous analysis, a portion of digester gas was directly used for steam production, with the steam then used for digester heating. A more efficient energy cycle and one that is consistent with the latest design thinking is to use all produced gas in the combined cycle plant or internal combustion engines and extract either steam or hot water for digester heating. Energy balances for the Phase II facilities assume steam extraction from the steam turbine or hot water from IC engines and subsequent use for digester heating.

TABLE VI-1
CAPITAL AND O & M COST FACTORS USED IN
ECONOMIC ANALYSIS OF PHASE II FACILITIES

ITEM	RATE	REMARKS
Labor	\$14.50/hr	Increased from \$12.50/hr by ratio of CPI. CPI for L.A./Long Beach, May 1979, given at 212.
Diesel	\$0.65/gal	Based on price quote of \$0.54/gal from Exxon, FOB L.A., and discussion with R. Howford.
Electricity	\$0.04/KWH	Based on conv. with J. Eppich, LACSD still paying average of \$0.03/KWH. Conv. with V. Varsh of CLA indicates current Hyperion rate of \$.04 to \$.045/KWH, expected to go to \$.05/kwh by Dec. 1979.
Polymer	\$2/lb	No change from previous factor (based on conv. with T. LeBrun).
Isopar-L	\$1.50/gal	Based on price quote of \$1.22/gal by Exxon and expected near term cost increase.
Dump Charge	\$3/wet ton	No change from previous factor (based on conv. with B. VanHuit).
ENR	3500	May 1979 index for L.A.
Amortization Factors	.09349 (20 years) .14156 (10 years) .24307 (5 years)	6-7/8% interest per Clean Water Grant Program Bulletin No. 61A.

Sludge loads corresponding to year 2000 raw PS and partial secondary treatment were assumed for the Phase II facilities. Options for sludge processing during Phase III assuming full secondary treatment are included in the facility descriptions.

Facilities for City of Los Angeles

PHASE II FACILITIES

Phase II facilities for the City of Los Angeles Hyperion Treatment Plant will, as a minimum, be sized to accommodate all sludge from primary treatment of 400 MGD of wastewater plus the waste activated sludge from secondary treatment of 150 MGD of primary effluent. Sludge loadings for the Phase II facilities projected to be produced by the year 2000 are given in Table VI-2.

The foregoing treatment levels have been specified in the City's application for waiver of secondary treatment requirements. Should additional secondary treatment be required, Phase II facilities would need to be expanded to accommodate a larger volume of waste activated sludge. A decision regarding the application for waiver of secondary treatment requirements has not yet been made. Should secondary treatment of all wastewaters be required, Phase II facilities requirements would be identical to the sludge loadings described for Phase III options.

UNIT PROCESSES

A process flow diagram for the proposed Phase II facilities is shown in Figure VI-1. All waste activated sludge (WAS) would be thickened and anaerobically digested, either separately or in combination with primary sludge (PS). Flexibility will be provided to allow operation in either mode. If necessary to achieve a net emission increase less than 150 pounds/day, digester gas will be processed for H₂S removal and a portion combusted in a combined cycle power generation system. The latter is capable of providing electrical power for plant operation and process steam for such uses as digester heating.

Currently, some digester gas is sold directly to the Scattergood Power Plant operated by City of Los Angeles Department of Water and Power, with the remainder used primarily in internal combustion (IC) engine drives. A decision has not been made regarding the quantity of digester gas to be combusted in the combined cycle plant and the number of IC engine drives to be retired from service. At a minimum, sufficient IC engines would be retired to assure compliance with new source (air emission) review requirements. Beyond this, remaining engines could continue in service, be replaced by the combined cycle facility or be retired and digester gas sold directly to Scattergood. Alternatively, all digester gas could be sold to Scattergood. However, analysis indicates that onsite power generation is likely the best long-term economic alternative for the Hyperion Treatment Plant. Therefore, a combined cycle power generation facility will be constructed at Hyperion for use of at least a portion of the digester gas production. A design decision regarding the exact size of the combined cycle power

TABLE VI-2
SLUDGE LOADING ON PHASE II FACILITIES
CITY OF LOS ANGELES HYPERION TREATMENT PLANT
Year 2000 PS Plus WAS From 150 MGD Secondary Treatment

PROCESS	FEED SLUDGE RATE (DRY TONS PER DAY) (a)			REMARKS
	PRIMARY	WAS	BLEND	
Raw Sludge to Anaerobic Digestion	335	85		Primary includes effect of side-stream recycle to headworks.
Mechanical Dewatering			280	Based on standard digester volatile solids reductions of 50 percent for primary VS and 30 percent for WAS VS. The Hyperion plant has a history of better than average VS reduction during digestion, approaching 60 to 65 percent. However, future plant process changes may reduce the VS destruction and it is prudent to use more standard values for facility planning and sizing.
Wet Cake Storage			265	Based on 95 percent capture in dewatering.
Dehydration			265	
Dry Product Storage			265	3-day storage (800 dry tons).
Thermal Processing			265	Assumes any extracted heavy oil returned to the dried product.
Char/Ash Storage			100	Assumes complete fixed carbon burnout. Would be about 125 dtpd with reduced burnout efficiency. Assume 3-day storage.
Enclosed Mechanical Composting Demonstration Facility				10 to 20 dtpd demonstration system is planned, but no fixed tonnage will be applied for purposes of sludge management until completion of the demonstration studies. Facility will be located at the Terminal Island Treatment Plant.

(a) All values rounded up to the nearest 5 dry tons per day (dtpd).

plant and extent of continued use of IC engines will be made early in the design phase of the program.

Liquid sludge storage will be provided for digested primary sludge and digested WAS. Blending tanks are also to be provided to assure proper proportioning and mixing of the two sludge types prior to dewatering or prior to digester feeding.

Digested PS and WAS will be mechanically dewatered prior to drying in the dehydration process. The latter includes sub-systems designed for fluidizing oil storage, sludge/oil mixing, sludge/oil grinding, multiple effect evaporation, deoiling, hydroextraction, heavy oil extraction, condensate clean-up, and pelletizing of the hydroextracted final product.

Dried product from the dehydration process will be thermally processed for energy recovery. The thermal process will likely consist of an initial gasification step to produce a synthetic fuel gas which will then be used for energy production. Energy from combustion will be extracted in a waste heat boiler. Steam will be used for electrical power generation in a steam turbine and for process applications in the dehydration system. Char and ash produced during thermal processing will be truck hauled to Lopez Canyon landfill for disposal.

An advanced air cleanup train will be used to reduce emissions of particulates, oxides of nitrogen and sulfur (NO_x and SO_x). Systems considered to accomplish pollutant reduction include bag houses or equivalent for particulate removal, NO_x reduction using ammonia injection, and SO_x removal by wet chemical scrubbing. Wet scrubbing will also be included to reduce the flue gas temperature for steam plume suppression. Flue gases will be directed through a stack for atmospheric dispersion. At this time, stack height is expected to be between 50 and 100 feet (from ground level) to provide dispersion of exhaust gases. Residues from the air cleanup equipment, such as dusts or lime sludges, will be truck hauled to Lopez Canyon landfill for ultimate disposal.

Liquid sidestreams produced during sludge processing will be recycled back to the treatment plant. It is common to return such sidestreams to the plant headworks. However, other return points are possible and may, in some cases, be desirable to achieve better plant operation. Whatever the case, final effluent discharge limitations will not be exceeded.

Storage

Intermediate storage facilities are provided at four points in the process train: (1) liquid digested sludge storage in fixed or floating cover storage tanks, (2) wet cake storage following mechanical dewatering, (3) dried pelletized sludge

storage following dehydration, and (4) char/ash storage following thermal processing. Temporary storage for about three days for liquid sludge, dried pelletized sludge and char/ash is envisioned. Storage requirements for wet cake will be between 1 and 3 days. Sizing of storage facility requirements will be finalized during detailed design.

Standby Capacity

The dehydration/thermal processing system will be designed on a modular basis. As a minimum, three modules will be provided, any two of which are capable of processing the full Phase II design sludge loading. Other modular arrangements which provide the same level of reliability and flexibility may be found during detailed design of facilities. However, a minimum of one module will be provided for standby purposes. Standby boiler capacity will be provided for use in the event of steam supply interruption.

The intermediate storage facilities represent additional backup in the event of temporary process shutdown. As such, the storage facilities are an essential element of the total process train and add to system reliability.

Demonstration Facility

LA/OMA public participation results indicate that increased awareness on the part of treatment plant neighbors and regulatory agencies will require increased efforts to control odors, nuisances, and pathogens associated with compost operations. Enclosed reactor composting offers considerable potential for improved operational stability, increased statistical reliability for pathogen destruction, and increased control over odor and dust nuisances. A modest scale facility sized for about 10 to 20 dtpd capacity will be constructed to verify this technology. Because it is demonstration in nature, however, all sludge processing will be accomplished in the primary parts of the system. The facility will include the following design elements: (1) mechanical metering and mixing of all materials into the composter, (2) an enclosed reactor capable of providing a high level of agitation and forced aeration, (3) collection, deodorization and dispersion of exhaust gases from the reactor, (4) pelletization of a portion of the reactor outfeed to investigate potential for reducing dust nuisances, (5) heat drying for a portion of the reactor outfeed to investigate the potential for reduced dependence on air drying, particularly during winter months; and (6) a high degree of dust control. The finished compost would be recycled through contract to private firms at offsite recycling centers or landfill disposed if recycling is not practical, due to regulatory constraints or lack of market demand. The City of Los Angeles will construct facilities for this demonstration at the Terminal Island Treatment plant. As such, engineering and environmental analyses will be included in a facilities plan and an impact statement to be prepared by the City of Los Angeles.

SITE LAYOUT

Preliminary layout of onsite facilities for sludge processing are shown in Figure VI-2. The facilities at Hyperion include WAS thickening, sludge blending tanks, anaerobic digestion, emergency liquid storage, sludge dewatering facilities, wet cake storage facilities, dehydration, dehydrated pelletized sludge storage, thermal processing, combined cycle power generation, and truck loading facilities for char/ash and residue hauling to landfill. Some of the facilities are existing, including most of the anaerobic digesters and buildings for mechanical dewatering and probably dehydration. Additionally, a facility for screening of sludge and digester cleaning is under construction and is considered to be an existing facility. Dried pellet storage, thermal processing, storage of char/ash and combined cycle power generation may occur in existing buildings if engineering design considerations allow. Other facilities and modifications of existing buildings would be new construction undertaken under Phase II. Mechanical composting demonstration facilities will be located at Terminal Island Treatment Plant.

There is concern on the part of the CLA Department of Airports regarding construction of a new stack at the northern part of the treatment plant. The City of Los Angeles' Department of Airports reports, however, that an exhaust stack less than 157 feet high would not constitute an aircraft obstruction. Sludge processing facilities were not sited at the southern end of the plant, adjacent to the existing conglomerate of buildings and stacks of the Scattergood Electricity Generating Station since the southern portion of the plant would be needed for additional secondary treatment - if such is required. Additional opportunities for relocation of the sludge processing facilities may arise if additional secondary treatment beyond 150 MGD is not required. For planning purposes, the preliminary facilities layout shown in Figure VI-2 will be used.

ULTIMATE DISPOSAL

Lopez Canyon landfill or other such landfill will be the ultimate disposal site for char/ash, and other residues such as may be derived from flue gas cleanup, sludge screening, or digester cleaning. At the present time, community incinerator ashes are classified as a Group I waste. If char/ash from thermal processing is considered a Group I waste, a special permit may be required for disposal to a Class II-1 landfill. If such a permit cannot be obtained for the Lopez Canyon site, char/ash would require disposal at a Class I landfill. BKK and Calabasas Landfills are the most likely Class I facilities for long term disposal.

Lopez Canyon landfill could also provide emergency backup for disposal of dewatered cake from Hyperion. This is expected to be an unlikely event, because of the standby mechanical systems and intermediate liquid and dewatered cake storage provided in the system. Should landfill disposal be required, the Regional Water Quality Control Board has indicated that at the Lopez Canyon site, 80-85 percent

moisture content sewage sludge could be mixed directly with the incoming refuse material with total water added to the refuse not to exceed 25 gallons per cubic yard (Ref. 1). A monitoring system would be required down-canyon from the disposal areas. If leachate was found to be generated a collection system would have to be constructed for treatment or discharge into a sanitary sewer system.

TRANSPORTATION ROUTES

Char/ash from thermal processing of sludge, and residues from digester cleaning and flue gas cleanup will be hauled by truck from Hyperion to the Lopez Canyon landfill. There are a number of possible truck routes between the treatment plant and the landfill site. The route shown in Figure VI-3 was selected, since significant truck traffic is already present and major contact with residential areas is avoided.

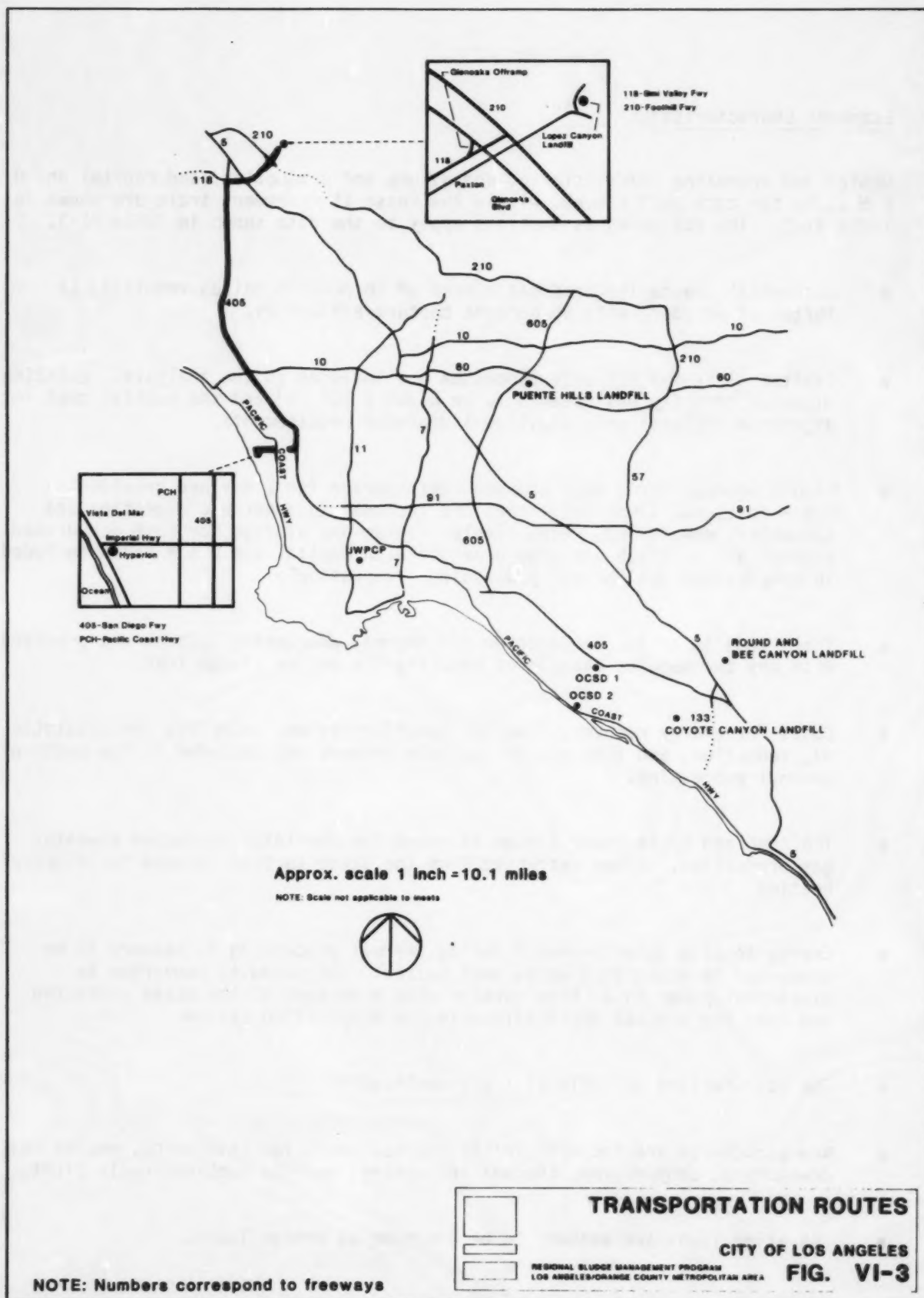
Assuming the selected route, trucks would leave the solids processing area at Hyperion and take Imperial Highway to the San Diego Freeway North. Transition would be made to the Simi Valley Freeway East. Trucks would exit at the Glenoaks offramp and proceed via Paxton Street to the Lopez Canyon site.

If it becomes necessary to truck residuals to Class I disposal sites, trucks would travel east on Imperial Highway to the San Diego Freeway. If Calabasas Class I Landfill is used, trucks would travel north on the San Diego Freeway to the westbound Ventura Freeway. Trucks would exit from the Ventura Freeway at Lost Hills Road and proceed to the landfill.

If BKK Class I Landfill site is used, trucks would travel south on the San Diego to the Long Beach Freeway, then north on the Long Beach Freeway to the Artesia Freeway to the northbound San Gabriel River Freeway. Trucks would travel north on the San Gabriel River Freeway to the eastbound Pomona Freeway. Trucks would exit from the Pomona Freeway at Azusa Avenue and travel north on Azusa Avenue to BKK Landfill.

QUANTITATIVE INFORMATION

Quantitative information has been developed by LA/OMA Project for the proposed Phase II facilities. This information, together with the foregoing qualitative description, was used in the assessment of the proposed sludge management program.



Economic Characteristics

Design and operating loads, sizing, energy use and production, and capital and O & M costs for each unit process within the Phase II treatment train are shown in Table VI-3. The following assumptions apply to the data shown in Table VI-3.

- Mechanical dewatering produces a cake of 18 percent solids requiring 11 lb/ton of polymer, with 95 percent capture efficiency.
- Capital costs for all unit processes are included in the analysis. Existing digester capacity was assumed to be $6.105 \times 10^6 \text{ ft}^3$ and the capital cost for digestion reflects only additional digester requirements.
- Liquid storage for 3 days and wet cake storage for 1 day are provided. O & M costs for these facilities are included in anaerobic digestion and mechanical dewatering, respectively. Three day storage for both dehydrated product and char/ash are also provided with Capital and O & M costs included in dehydration and thermal processing, respectively.
- Three modules of the dehydration and thermal processing systems are provided with any two modules capable of handling the entire sludge load.
- Costs for energy recover, flue gas desulfurization, selective non-catalytic NO_x reduction, and flue gas particulate removal are included in the costs of thermal processing.
- The combined cycle power system is sized for the total projected digester gas production. Steam extracted from the steam turbine is used for digester heating.
- Energy in flue gases produced during thermal processing is assumed to be converted to steam in a waste heat boiler. The steam is converted to electrical power in a steam turbine with a portion of the steam extracted and used for process applications in the dehydration system.
- The cost factors in Table VI-1 are applicable.
- New structures are included in the capital costs for thickening, mechanical dewatering, dehydration, thermal processing, and the combined cycle plant.
- Operating loads are assumed to be the same as design loads.

TABLE VI-3

QUANTITATIVE CHARACTERISTICS OF PHASE II FACILITIES
SIZING, ENERGY AND COSTS

City of Los Angeles - Hyperion

HYPERION - CLA	THICK- ENING	ANAEROBIC DIGESTION	LIQUID STORAGE	MECHANICAL DEWATERING	WET CAKE STORAGE	DEHYDRA- TION	THERMAL PROCESSING	CHAR/ASH TRUCK	COMBINED CYCLE PLANT	TOTAL
320 dry tons per day - PS										
84 dry tons per day - MAS										
DESIGN LOADING (dry tons/day) a. (* tons of H ₂ O/day)	88	418	278	278	264	1204*	264	99	-	404
OPERATING LOAD (dry tons/day) b. (* tons of H ₂ O/day)	88	418	278	278	264	1204*	264	99	-	404
SIZING										
LAND AREA REQUIRED (acres)	0.4	0.3	1.3	1.5	0.1	0.9	1.4	-	0.2	6.1
EMPLOYEES (No. per 24 hrs)	6	9		12		8	5	3	9	52
POLYMER USED (lbs/day)	265			3061						3326
ISOPAR L USED (gal/day)						777				777
O ₂ FOR RECYCLE (tons/day)				1.3		1.4				2.7
ENERGY										
ELECTRICITY USED (KWH/DAY)	8842	28137		11841		39740	20227			108787
ELECTRICITY PRODUCED (KWH/DAY)							101928		245904	347832
FUEL OIL USED (gal/day)										0
FUEL PRODUCED (tons/day)										0
DIESEL FUEL USED (gal/day)								118		118
O ₂ FOR RECYCLE (KWH/DAY)				391		446				837

a. Design load refers to the tonnage of solids or water used for estimation of capital costs.
b. Operating load refers to the tonnage of solids or water used for estimation of O & M costs.

TABLE VI-3 (Continued)
 QUANTITATIVE CHARACTERISTICS OF PHASE II FACILITIES
 SIZING, ENERGY AND COSTS

City of Los Angeles - Hyperion

HYPERION - CLA	THICK- ENING	ANAEROBIC DIGESTION	LIQUID STORAGE	MECHANICAL DEWATERING	WET CAKE STORAGE	DEHYDRATION	THERMAL PROCESSING	CHAR/ASH TRUCK	COMBINED CYCLE PLANT	TOTAL
320 dry tons per day - PS										
84 dry tons per day - WAS										
CAPITAL COST (\$000)										
LAND	0	0	0	0	0	0	0		0	
STRUCTURAL	C.	C.	C.	2039	C.	2462	2402	C.	221	7124
PROCESS	4755	1185	5904	7113	1863	27840	24108	333	5685	78786
TOTAL CAPITAL	4755	1185	5904	9152	1863	30302	26510	333	5906	85910
TOTAL ANNUAL CAPITAL	445	111	552	856	174	2833	2478	81	552	8082
OPERATIONS AND MAINTENANCE										
COST (\$000)										
LABOR	302	452		603		402	251	151	452	2613
DIESEL FUEL								28		28
FUEL OIL										0
ELECTRICITY	129	411		173		580	295			1588
POLYMERS	194			2234						2428
ISOPAR L						426				426
MAINTENANCE	13	104		257		850	769	37	166	2196
RECYCLE OXYGEN				14		16				30
DUMP CHARGE								108		108
TOTAL ANNUAL O & M	638	967		3281		2274	1315	324	618	9417
CREDITS (\$000)										
SALE OF COMPOST										
VALUE OF FUEL							-1488		-3590	-5078
VALUE OF ELECTRICITY							-1488		-3590	-5078
TOTAL ANNUAL CREDITS						2274	-173	324	-2972	4339
NET ANNUAL O & M COST (\$000/YR)	639	967		3281						
TOTAL NET ANNUAL CAPITAL AND O & M COST (\$000/YR)	1083	1078	552	4137	174	5107	2305	405	-2420	12421
TOTAL ANNUAL COST/TON OF DRY FEED (\$/TON)	33.7	7.1	5.4	40.7	1.8	52.9	23.9	11.3	-	84.2

c. Structural cost included in process cost.

Based on these assumptions, a total capital cost of \$85,910,000 is estimated, which is equivalent to \$8,082,000/yr. Total annual O & M is estimated at \$9,417,000/yr with credits for the value of net electricity produced at \$5,078,000/yr. The net cost, defined as annual capital plus O & M less credits, is about \$12,421,000/yr. The latter is equivalent to about \$84.2/dry ton of raw sludge processed through the system.

Air Pollutant Emissions

Air pollutant mass emission estimates are shown in Table VI-4 for the Phase II facilities that would be located at the City of Los Angeles Hyperion Treatment Plant.

The proposed sludge management facilities will result in net production of surplus electrical power which will be used primarily to satisfy electrical power requirements for wastewater treatment. If such surplus power were not produced from sludge processing, the electricity required for wastewater treatment would be purchased from electrical utilities. Therefore compensating emission offset reductions, equal to the air emissions expected to occur from a Southern California utility using fuel oil to produce electricity equivalent to the net surplus electricity from sludge processing, have been calculated and are shown in Table VI-4.

Air pollution emission estimates have been developed by the LA/OMA Project from application of unit emission factors shown in Chapter VII. Factors for total suspended particulates (TSP), nitrous oxide (NO_x), sulfur oxides (SO_x), hydrocarbons (HC), and carbon monoxide (CO) have been developed through literature reviews, field and laboratory testing, and consultations with manufacturers, air quality regulatory and planning agencies, and private consultants.

The City of Los Angeles has filed with the South Coast Air Quality Management District an application for a permit to construct and operate waste heat boilers, dehydration process, thermal processing and combined cycle power generation facilities. Action on the permit has not been completed.

Air pollutant mass emissions have been developed for two cases. Use of these two cases in the environmental impact analysis assures that a range of potential impacts is identified and effects of uncertainty associated with development of the emissions estimates would be minimized.

The "reasonable planning case" has been defined based upon use of sophisticated air emission control equipment and operation of such equipment at the design removal efficiencies. Specific assumptions underlying the "reasonable planning" case are: (1) 80 percent removal of hydrogen sulfide from digester gas prior to

TABLE VI-4

ESTIMATED AIR POLLUTANT MASS EMISSION RATES FOR PHASE II FACILITIES CITY OF LOS ANGELES

Year 2000 PS Plus WAS from 150 MGD Secondary Treatment

(All values in pounds per day.)

SCENARIO CASE UNIT PROCESS	HC AS CH ₄	CO AS CO	SO AS SO ₂	NO AS NO ₂	TSP
1978 BASE EMISSIONS (1,3)	1935	595	220	4705	125
FULL CCP USE					
Reasonable Planning Case					
Thermal Processing	20	35	399	229	117
Trucking	3	20	2	15	2
Combined Cycle	89	347	86	867	40
IC Engines	--	--	--	--	--
Total (1)	115	405	490	1115	160
Reasonable Worst Case					
Thermal Processing	25	44	798	1147	146
Trucking	4	25	3	19	3
Combined Cycle	111	434	539	1084	50
IC Engines	--	--	--	--	--
Total (1)	140	505	1340	2250	200
Emission Offsets From (1,2) Electrical Production	45	50	650	550	100
PARTIAL CCP USE					
Reasonable Planning Case					
Thermal Processing	20	35	399	229	117
Trucking	3	20	2	15	2
Combined Cycle	65	255	63	637	30
IC Engines	1074	330	23	2608	68
Total (1)	1165	640	490	3490	220
Reasonable Worst Case					
Thermal Processing	25	44	798	1147	146
Trucking	4	25	3	19	3
Combined Cycle	82	319	396	797	37
IC Engines	1074	330	143	2608	68
Total (1)	1185	720	1340	4575	255
Emission Offsets From (1,2) Electrical Production	35	35	470	400	70

- (1) Values are rounded up to nearest 5 pounds/day.
- (2) Compensating emissions resulting from production of energy by sludge processing which would otherwise be supplied by an electrical utility.
- (3) Includes only emissions from onsite operation of IC engines and boilers. A portion of the digester gas is used offsite by the Department of Water and Power at the adjacent Scattergood Steam Plant. Emissions for offsite uses of digester gas were not included to assure that the analysis would be conservative. Inclusion of such emissions would increase the 1978 Base inventory.

combustion, (2) selective catalytic reduction to achieve 90 percent removal of NO_x in flue gas from the thermal processing reactor, (3) fabric filters for particulate removal to achieve a particulate concentration of 0.01 grains per actual cubic foot at 400°F in the flue gas from thermal processing, (4) flue gas desulfurization to achieve a concentration of 0.221 pounds per ton - wet basis (a concentration of about 50 ppm (v)) in the flue gas from the thermal processing reactor, and (5) other emission factors as shown in Table VII-5.

The "reasonable worst case" has been defined based upon the assumption that air emission cleanup equipment would function at less than design efficiencies and in some instances, inclusion of lower levels of control. Complete failure of a process or its associated air emission control system was not included since the modular design of most systems would include standby capacity for sludge processing and air emission controls. Specific assumptions underlying the "reasonable worst case" are (1) no removal of hydrogen sulfide from digester gas, (2) flue gas desulfurization achieves 100 ppm (v) in flue gas from the thermal processing reactor, (3) use of selective non-catalytic reduction to achieve 50 percent NO_x removal in flue gas from thermal processing, and (4) other emission factors shown in Table VII-5 (excluding those for reciprocating engines and electrical utility power generation) are increased by 25 percent, including the hydrogen sulfide content of digester gas.

Since a final decision on the extent of continued use of digester gas in existing internal combustion engines has not been made, air pollutant mass emissions have also been developed for (1) complete abandonment of use of digester gas in internal combustion engines and use of all digester gas in a combined cycle electrical generation system (Full CCP) and (2) continued use of digester gas in existing internal combustion engines for five existing blower drives, retirement of five existing internal combustion engine generator drives, and use of all remaining digester gas in a combined cycle powerplant (Partial CCP). A range of emission estimates is thus provided which enables evaluation of the impacts associated with continued use of internal combustion engines.

The foregoing estimates are not meant to imply that lower emission levels are not attainable. There is good evidence that lower particulate and sulfur dioxide emissions from thermal processing would be achievable with application of innovative techniques and control systems (Ref. 2). It is also recognized that selective catalytic NO_x reduction systems have not been reliably demonstrated in applications involving solid fuels. On the other hand, there appear to be good prospects that non-selective catalytic NO_x reduction systems can achieve greater than 50 percent removal efficiencies in the type of application envisioned by the proposed sludge management project. Questions of this nature should be resolvable by incorporation of any needed mitigation measures (if the environmental analysis based upon the range of air pollutant mass emissions given in Table VI-4 discloses significant adverse impacts) and during design of facilities.

Referring to Table VI-4 and comparing to 1978 estimated levels, large emission reductions for both HC and NO_x are predicted. Emission levels for CO would

remain about the same, with a slight increase shown for TSP. SO_x is the only pollutant for which a significant increase is shown. Furthermore, the extent of the increase in SO_x is largely dependent on whether the design case or worst case is considered. It should be noted that if 90 percent H_2S removal were achieved from digester gas and a final flue gas SO_2 concentration of 25 ppm (v) from thermal processing, the mass emission rate for SO_2 would be 245 lb/day, which is only a slight increase over 1978 estimated levels.

The Phase II facilities will result in the net production of electrical power, which will be used primarily to satisfy wastewater treatment requirements. If power were not produced from sludge processing, electricity required for wastewater treatment would have to be purchased from electrical utilities. Therefore, emission offsets equal to the air emissions expected from a Southern California utility using fuel oil to produce an equivalent amount of net electricity are shown in Table VI-4. The emission offset for SO_x is quite significant. When compared to the reasonable design case, an actual reduction in SO_x mass emission rate is predicted, with essentially equivalent levels for the reasonable worst case. Therefore, if electrical offsets are considered, the Phase II facilities will result in reduction in HC and NO_x from 1978 base conditions, and nearly equivalent mass emission rates for CO, SO_x and TSP.

LA/OMA Project information (Ref. 2) shows that planning case emission levels can be achieved in all cases with the possible exception of catalytic NO_x reduction from thermal processing. Thus, projected NO_x emissions from thermal processing appear to be closer to the reasonable worst case level. In some cases, including particulate and SO_x control on flue gas from thermal processing, more stringent emission controls may be achievable. Direct SO_x emissions will depend largely on whether H_2S is removed from digester gas prior to combustion. Direct SO_x emissions greater than the reasonable planning case would result if H_2S is not removed from digester gas, or equivalent SO_x reductions are not achieved from other in-plant sources. The following direct project emission are projected to result assuming reasonable planning case emission levels for HC, CO, and TSP; planning case emission levels for NO_x , except for thermal processing where reasonable worst case emissions are assumed; and reasonable planning case emissions for SO_x , both with and without H_2S removal.

Full CCP

HC 115 lb/day

CO 405 lb/day

SO_x 835 lb/day (No H_2S removal),
490 lb/day (with H_2S removal
to 80 percent efficiency).

NO_x 2030 lb/day

TSP 160 lb/day

Partial CCP

HC 1165 lb/day

CO 640 lb/day

SO_x 835 lb/day (No H_2S removal),
490 lb/day (with H_2S removal
at 80 percent efficiency).

NO_x 4410 lb/day

TSP 220 lb/day

As stated above, opportunities exist to further reduce direct air emissions resulting from the Phase II facilities. In some cases these emission reductions are achievable with application of innovative control techniques which may not be entirely proven in facilities of a similar nature. The following control measures are available to further reduce direct project emissions and are judged to have a high probability of successful application.

- Increased efficiency of particulate removal from the thermal processing flue gas. (Potential reduction of about 110 lb/day. Based on achieving 0.0005 gr/ACF in flue gas).
- Increased efficiency of H₂S removal from digester gas prior to combustion. (Potential reduction of about 40 lb/day SO_x as SO₂ compared to reasonable planning case and 385 lb/day compared to no H₂S removal. Based on 90% removal efficiency.)
- Increased efficiency of flue gas desulfurization (FGD) from the thermal processing system. (Potential reduction of about 240 lb/day SO_x as SO₂ from reasonable planning case. Based on 20 ppm(v) in flue gas.)
- Water injection for NO_x control in CCP. (Potential reduction 490 lb/day NO_x as NO₂. Based on 0.13 lb NO_x/mm BTU of fuel consumed.)
- Operation of the thermal processing reactor in a uniform, standby-state manner to realize the optimum removal efficiency possible from selective non-catalytic NO_x reduction. (Potential reduction of 230 to 460 lb/day NO_x as NO₂ compared to reasonable worst case. Based on 60 and 70% removal efficiencies.)
- Selective catalytic or non-catalytic NO_x control on flue gas from the combined cycle power plant. (Potential reduction of 430 to 780 lb/day NO_x as NO₂ compared to reasonable design case. Based on 50 and 90 percent removal efficiencies.)
- Replacement of all internal combustion engines by the combined cycle facility. (See Table VI-4 for potential emission reductions)

Incremental increases in ground level concentrations of oxides of nitrogen (NO_x), oxides of sulfur (SO_x), particulated (TSP), carbon monoxide (CO), and hydrocarbons (HC) were estimated for the proposed Phase II Facilities and the Phase III Option. Ground level concentrations were estimated using the standard Gaussian dispersion model and calculation procedures described by Turner and Budney (Ref. 3,4). Stack heights and exhaust gas temperature and velocities consistent with good engineering practice were assumed. A number of wind speeds were examined in

the analysis. Assumptions used in the development of ground level concentrations are:

- Gaussian dispersion model using Pasquill-Gifford dispersion coefficients. Maximum centerline concentrations used in the analysis.
- Atmospheric stability class "D" as recommended by staff of the South Coast Air Quality Management District (Ref. 5.).
- Assumed stack heights of (1) thermal processing, 100 feet; (2) combined cycle plant, 50 feet; (3) boilers, 30 feet; and (4) internal combustion engines, 35 feet.
- Plume rise calculation using Brigg's Formula.
- Velocity of stack discharges - 50 feet per second (15.2 meters per sec.).
- Flue gas exhaust temperature of (1) thermal processing, 175°F; (2) combined cycle plant, 250°F; (3) boilers, 350°F; and (4) internal combustion engines, 350°F at Hyperion.
- Critical wind velocity (the wind velocity resulting in maximum centerline ground level concentrations) were examined in each case.
- A "high" wind case based upon the average of the highest four mean hourly wind speeds for all directions and a "low" wind case based upon the average of the lowest four mean hourly wind speeds.
- Wind speed data taken during 1956-76 for Los Angeles International Airport.

Only stationary sources were included in the analysis. Although emissions from mobile sources are a significant regional problem, analysis indicates that the levels associated with the proposed facilities would not be substantial at the local level, since projected mass emission rates are small and will be widely dispersed. Construction emissions were not included because substantial long-term emissions are not anticipated.

Estimated incremental increased in 1-hour ground level increases for the reasonable worst case emission levels are shown in Table VI-5. The concentrations shown are maximum centerline ground level concentrations separately calculated for each discharge point. Values are shown for internal combustion engines (IC),

TABLE VI-5
PROJECTED 1 HR. MAXIMUM GROUND LEVEL CONCENTRATIONS OF AIR POLLUTANTS
CITY OF LOS ANGELES - HYPERION TREATMENT PLANT
Reasonable Worst Case Emissions

	PROJECTED GROUND LEVEL CONCENTRATIONS (1-HR.) IN ug/M3							
	LOW WIND CASE ($u_L=1.63$ m/sec)				HIGH WIND CASE ($u_H=5.49$ m/sec)			
	IC	CCP	DFTP		IC	CCP	DFTP	CRITICAL WIND CASE, u_C
1978 BASE								
NOx	332				630			661
SOx	16				30			31
TSP	9				17			18
CO	42				80			84
HC	136				260			272
PHASE II (PARTIAL CCP)								
NOx	402	53	51		602	86	58	606
SOx	22	26	36		33	42	40	33
TSP	11	2	7		17	4	7	17
CO	52	21	2		77	34	2	78
HC	166	5	1		250	8	1	251
								89
								43
								17
								35
								9
								1
								59
								41
								8
								2
								1
PHASE II (FULL CCP)								
NOx	51	51	51		86	58	58	93
SOx	25	36	40		42	40	41	45
TSP	3	7	7		5	7	8	5
CO	21	2	2		35	2	2	38
HC	5	1	1		9	1	1	10
								98
								64
								45
								48
								4
								40
								2
								10
								1
PHASE III								
NOx	48	50	64		88	64	64	98
SOx	23	35	45		44	45	45	48
TSP	2	6	8		4	8	8	4
CO	19	2	2		36	2	2	40
HC	5	1	1		9	1	1	10

SOURCE: LA/DNA Project

NOTE: a. Reasonable worst case emission levels were assumed. Mobile emissions were not included in the analysis.
b. Low wind speed is the average of the lowest 4 mean hourly wind speeds for all directions based on 1956-1976 data collected at Los Angeles International Airport. High wind speed is the average of the highest 4 mean hourly wind speeds. Critical wind speed is that calculated to give the maximum ground level concentration.

combined cycle powerplant (CCP), and thermal processing reactor (DFTP). Estimates are given for concentrations resulting from continued use of IC engines (Partial CCP scenario) and complete abandonment of stationary IC engines (Full CCP scenario).

Ground level increments estimated for the individual point sources are not directly additive, since the indicated concentrations do not usually occur at the same location. Distance from the source to the maximum centerline concentration varies significantly depending upon the characteristics of the discharge. In addition, ground level concentrations decrease rapidly with increasing lateral distance from the plume centerline. Thus it is unlikely that superimposed concentrations from individual sources would substantially exceed those calculated for the point of maximum ground level concentration. Therefore, ground level concentrations from each of the sources listed in Table VI-5 were considered separately.

Special plume transport and dispersion conditions known as looping, limited mixing, coning, fanning, and fumigation were evaluated using recommended EPA procedures (Ref. 3). These transport conditions can potentially result in high short-term concentrations, however, analysis indicates concentrations significantly different from the maximum 1-hour concentrations shown in Table VI-5 should not result from these transport phenomena. In view of this finding, no further consideration was given to these special transport conditions.

Downwash is a condition in which aerodynamic turbulence induced by a building causes a pollutant emitted from an elevated source to be mixed rapidly toward the ground. Analysis indicates a possibility for downwash, although, it is believed that proper facility design can avoid such a condition.

The estimated maximum ground level concentrations assume a constant wind speed and an averaging time of about one hour. Increasing the averaging time would reduce the values shown in Table VI-5 because of the time interval would encompass more variations in wind speed, direction, and stability class. EPA guidelines state that a factor of 0.4 (+0.2) should be used in adjusting 1-hour concentrations to a 24-hour averaging time (Ref. 4). On an annual average basis it would not be unreasonable to expect an order of magnitude reduction in average ground level concentration from the indicated 1-hour maximum.

Projected ground level concentrations for the reasonable worst case emission levels at Hyperion, will meet the corresponding ambient air standards, except for the case of NO_x from existing IC engines in Phase II. Using the same procedure, NO_x levels for 1978 base conditions also violate the ambient air standard. Comparing the 1978 base condition to the Phase II (partial CCP) option, pollutant contribution attributable to IC engines remains about the same, but there would be increases in concentrations of NO_x , SO_x and CO from the addition of the CCP and DFTP. However, the full CCP option eliminates the contribution from IC engines, resulting in net decreases in concentrations for all pollutants, except

for SO_x , which would increase slightly over the 1978 level. Therefore, it appears that a probable violation of NO_x standard may result in Phase II due to continued use of existing IC engines. However, whether the projected violation would actually occur, would depend on many other meteorological factors, and the frequency of violation is not expected to be high. It was found that increasing the IC engine stack height from the present 35 feet to 75 feet, would reduce the incremental increase to levels less than ambient air standards.

The air emission analysis included evaluation of the potential discharge of heavy metals during thermal processing and related health impacts. Details of the analysis are presented in Ref 6. A major conclusion of the analysis was that negligible health effect would be expected, based on the proposed design of the thermal processing system. Stack heights of 50 to 150 feet appeared to be acceptable for dispersion purposes. In order to limit the release of toxicant containing particulates into the environment, extremely efficient particulate control devices should be used, such as a fabric filter baghouse. Particular attention should be given to capture of submicron particles. It was recommended that total particulate loading in the exhaust flue gas be kept at 0.01 gr/ACF or lower, preferably at the state of the art design and that adequate air monitoring and sampling be done to assure reliable performance.

Transportation Requirements

It is projected that approximately 170 cubic yards per day of char/ash would be transported from the Hyperion Treatment Plant for disposal. Assuming such material is trucked to Lopez Canyon, approximately 2,290 round trips would be made annually resulting in a total of about 174,000 vehicle miles travelled (VMT) per year. Assuming 300 working days per year and eight hours per working day, a truck interval of 30 minutes between trucks is calculated.

If char/ash is not accepted for disposal at Lopez Canyon, such material would be transported either to Calabasas Class I Landfill or BKK Class I Landfill for disposal. Table VI-6 describes transportation requirements associated with both hauling to both landfills and compares such requirements with hauling to Lopez Canyon Landfill.

The foregoing information is applicable only to use of public streets and thoroughfares and does not include transportation activities occurring entirely within project boundaries.

TABLE VI-6

CHAR/ASH TRUCKING COMPARISON FOR PHASE II
CITY OF LOS ANGELES

Year 2000 PS Plus WAS from 150 MGD Secondary Treatment

	HYPERION TO LOPEZ	HYPERION TO BKK	HYPERION TO CALABASAS
Tonnage, dtpd	95	95	95
One-Way Distance (Miles)	38	43	39
Annual Capital Cost (\$000/Yr.)(1)	81	92	83
O & M Costs (\$000/Yr)(2)			
Fuel, Labor, Maintenance	216	244	221
Dump Charge	108	108	108
Total	324	352	329
Diesel Fuel (Gal/Day)(3)	118	134	121
Emissions (Lb/Day)(4)			
TSP	2	2	2
NO _x	15	17	16
SO ₂	2	3	2
CO	20	23	21
HC	3	4	3
Cubic Yards/Day	170	170	170
Round Trips/Yr	2,290	2,290	2,290
VMT/Yr	174,000	197,000	178,000
Truck Interval (Min)/Trip(5)	30	30	30

- (1) Directly proportional from Lopez case by mileage hauled. Note that capital cost is the same regardless of whether 2 or 3 C-G modules are operated since trucks must be available for maximum load.
- (2) Fuel, labor and maintenance directly proportioned from Lopez case using mileage and tonnage hauled. Dump charge \$3/ton.
- (3) Directly proportioned from Lopez case using mileage and tonnage hauled.
- (4) Based on diesel fuel use, 135,000 BTU/Gal., and standard emission factors.
- (5) Minutes between trucks.

Public Facilities Requirements

Public facilities demands are presented in Table VI-7 in terms of solid waste to be managed and disposed of in landfills; liquid sidestreams produced during sludge processing which would be recycled to the wastewater treatment plant; cooling water requirements; and potable water supply demands.

The largest single residual requiring disposal in landfills would be char/ash from thermal processing. Lesser amounts would be produced by the flue gas desulfurization system and digester cleaning operations.

Sidestreams would result from mechanical dewatering and condensate from dehydration and thermal processing. Cooling water required for dehydration; thermal processing, and combined cycle power generation would be obtained through reclamation of secondary wastewaters. Filtration of secondary effluent may be required. While it is believed unlikely, if secondary effluent cannot be used, cooling water demands would need to be met from potable water sources.

Potable water is required for digester heating and for condensate makeup water for dehydration and the steam turbine included in the thermal processing systems for energy recovery.

Energy Production and Consumption

Energy production and consumption arising from the proposed program is shown in Table VI-8. Electrical energy is produced from thermal processing and combustion of digester gas in the combined cycle power system. Assuming that all digester gas is used in the combined cycle facility, a net electrical production of about 238,400 KWH/day (9.9 MW) is projected. Diesel fuel, Isopar fluidizing oil, and polymer will be consumed by the process. The electrical equivalent of these organics is about 17,600 KWH/day, or about 7 percent of the net electricity produced. Thus, operation of the Phase II facilities will result in net production of energy.

In addition to electrical consumption demands, projected consumption of diesel fuel for truck transport of residuals to landfill; makeup requirements for ISOPAR (a fractionated isoparaffinic hydrocarbon) lost during dehydration; and polymer consumption for conditioning of sludge prior to dewatering are also reported.

TABLE VI-7

PUBLIC FACILITIES DEMANDS FOR PHASE II
CITY OF LOS ANGELES

Year 2000 PS Plus WAS from 150 MGD Secondary Treatment

PROCESS	SOLID WASTE (WTPD) ^(a)	SIDESTREAMS (MGD) ^(b)	COOLING WATER (MGD) ^(b)	POTABLE WATER (MGD) ^(c)
WAS Thickening	0	0.9	0	--
Anaerobic Digestion	0	0	0	0.085
Mechanical Dewatering	0	1.8	0	--
Dehydration	0	0.3	3.6	(g)
Thermal Processing	125(d)	0.4	4.0	0.025
Combined Cycle	0	0	3.8	--
Char/Ash to Landfill	125(d)	--	--	--
Digester Residue to Landfill	350WTPYR(e)	--	--	--
Baghouse Residue to Landfill	Included as part of char/ ash	--	--	--
Flue Gas Desul- furization Scrubber Sludge	35(f)	--	--	--

(a) Wet tons per day (WTPD) except as otherwise indicated.

(b) Values rounded up to nearest 0.1 million gallons per day (MGD).

(c) Values rounded up to nearest 0.005 MGD.

(d) Rounded to nearest 5 WTPD. Represents probably worst case with reduced fixed carbon efficiency. About 100 WTPD if carbon burnout is 10 percent.

(e) Wet tons per year (WTPYR) rounded to nearest 50 WTPYR.

(f) Rounded to nearest 5 WTPD.

(g) Includes condensate makeup water for dehydration and steam turbine system associated with thermal processing.

TABLE VI-8
ENERGY PRODUCTION AND CONSUMPTION FOR PHASE II
CITY OF LOS ANGELES
Year 2000 PS Plus WAS from 150 MGD Secondary Treatment

PROCESS	ELECTRICITY PRODUCED (1,2) (KWH/DAY)	ELECTRICITY CONSUMED (1) (KWH/DAY)	NET ELECTRICAL PRODUCTION (1) (KWH/DAY)	DIESEL FUEL CONSUMED (4) (GALLONS/DAY)	ISOPAR CONSUMED (4) (GALLONS/DAY)	POLYMER CONSUMED (4) (LB/DAY)
WAS Thickening	---	8,800	-8,800	---	---	300
Anaerobic Digestion	---	28,100	-28,800	---	---	---
Mechanical Dewatering	---	11,800	-11,800	---	---	3,100
Dehydration	---	39,700	-39,700	---	780	---
Thermal Processing	101,900	20,200	81,700	---	---	---
Truck Transport(3)	---	---	---	120	---	---
Combined Cycle Power Generation	245,900	---	245,900	---	---	---
Sidestream Processing	---	800	-800	---	---	---
TOTAL	347,800	109,400	238,400	120	780	3,400

(1) All values rounded to nearest 100 kilowatt hours per day (KWH/day).

(2) Assumes all digester gas is used in the combined cycle power generation system.

(3) Trucking of residues to Lopez Canyon Landfill.

(4) Electrical equivalent of diesel fuel, Isopar oil, and polymer organics is about 13 KWH/gal, 13 KWH/gal, and 1.73 KWH/lb, respectively.

PHASE III OPTIONS

Phase III options have been defined for each of the LA/OMA operating agencies from information available at the time of program development. It is recognized that new information may become available during Phase II which could alter the range of options available during Phase III. The Phase III options, however, provide identification of currently indicated long range alternatives. For the City of Los Angeles, the most reasonable Phase III option appears to be expansion of the Phase II dehydration/thermal processing system.

Projected sludge loadings for Phase III options are given in Table VI-9 and accommodate all sludge from primary treatment of 400 MGD of wastewater and secondary treatment of all primary effluent. With respect to the level of secondary treatment that may ultimately be required, the Phase III option would accommodate sludges produced by "full secondary treatment".

The Phase III option represents an upper limit for sizing of the Phase II facilities. Analysis of the Phase III option provides a description of the maximum potential environmental impact that might be realized if full secondary treatment of wastewaters or other factors necessitate expansion of Phase II facilities capacity beyond that described earlier.

Quantitative information for the Phase III option is provided in the following sections. Such information has been developed using the same unit factors as was used in development of quantitative information for Phase II facilities.

Economic Characteristics. Project costs were examined under Phase III conditions of year 2000 PS with full secondary treatment. Results are shown in Table VI-10. Capital costs could increase to as much as \$138,000,000 and net annual costs (annual capital + O & M credits) to \$18,082,000/yr due to the increased quantity of secondary sludge. These results are consistent with previous analyses which indicated the level of secondary treatment to be a major sensitivity effecting project costs.

Air Pollutant Emissions: Table VI-11 shows projected mass emissions of air pollutants for the Phase III option. The values shown in the table assume for purposes of analysis, that all digester gas will be used in the combined cycle system and no internal combustion engines will be used for generator or blower drives. Compared to 1978 base emissions, large emission reductions for both HC and NO_x and expected CO emissions would remain about the same. TSP emissions under the reasonable design case, would increase by about 100 lbs/day, which is about equal to the electrical offset for TSP under Phase III conditions. An increase in SO_x emissions of about 465 lb/day is projected under the reasonable design case. However, this increase is less than the electrical offset under Phase III.

TABLE VI-9
 MAXIMUM POTENTIAL SLUDGE LOADING ON PHASE III FACILITIES
 CITY OF LOS ANGELES HYPERION TREATMENT PLANT
 Year 2000 PS Plus WAS From Full Secondary Treatment

PROCESS	FEED SLUDGE RATE (DRY TONS PER DAY) (a)			REMARKS
	PRIMARY	WAS	BLEND	
Raw Sludge to Anaerobic Digestion	340	220		Includes effect of sidestream recycle to headworks.
Mechanical Dewatering			390	Based on standard digester volatile solids reductions of 50 percent for primary VS and 30 percent for WAS VS. The Hyperion plant has a history of better than average VS reduction during digestion, approaching 60 to 65 percent. However, future plant process changes may reduce the VS destruction and it is prudent to use more standard values for facility planning and sizing.
Wet Cake Storage			370	Based on 95 percent capture.
Dehydration			370	
Dry Product Storage			370	Assume 3-day storage (1100 dry tons).
Thermal Processing			370	Assumes any extracted heavy oil returned to the dried product.
Char/Ash Storage			130	Based on total fixed carbon burnout. Would be about 160 dtpd with reduced burnout efficiency.

(a) All values rounded up to the nearest 5 dry tons per day (dtpd).

TABLE VI-10

QUANTITATIVE CHARACTERISTICS OF PHASE III FACILITIES
DEHYDRATION AND ENERGY RECOVERY
CITY OF LOS ANGELES - HYPERION

Full Secondary Treatment - Year 2000 Sludge Loads

HYPERION - CLA	THICK- ENING	ANAEROBIC DIGESTION	LIQUID STORAGE	MECHANICAL DEWATERING	WET CAKE STORAGE	C-G DRYING	THERMAL PROCESSING	CHAR/ASH TRUCK	COMBINED CYCLE PLANT	TOTAL
320 dry tons per day - PS										
84 dry tons per day - WAS										
DESIGN LOADING (dry tons/day) ^a . (* tons of H ₂ O/day)	232	559	388	388	369	1687* ^c	369	128	-	540
OPERATING LOAD (dry tons/day) ^b . (* tons of H ₂ O/day)	232	559	388	388	369	1687* ^c	369	128	-	540
SIZING										
LAND AREA REQUIRED (acres)	0.9	3.9	1.6	1.7	0.2	0.9	1.5		0.2	10.9
EMPLOYEES (No. per 24 hrs)	12	15		15		8	5	4	9	68
POLYMER USED (lbs/day)	700			4300						5000
ISOPAR L USED (gal/day)						1080				1080
O ₂ FOR RECYCLE (tons/day)				1.8		1.4				3.2
ENERGY										
ELECTRICITY USED (KWH/DAY)	23200	39400		13800		55400	29300			162100
ELECTRICITY PRODUCED (KWH/DAY)							150300		298000	448300
DIESEL FUEL USED (gal/day)								150		150
O ₂ FOR RECYCLE (KWH/DAY)				575		449				1024

a. Design load refers to the tonnage of solids or water used for estimation of capital costs.

b. Operating load refers to the tonnage of solids or water used for estimation of O & M costs.

c. Corresponds to 18 percent cake solids for dewatering.

TABLE VI-10 (Continued)

QUANTITATIVE CHARACTERISTICS OF PHASE III FACILITIES
DEHYDRATION AND ENERGY RECOVERY
CITY OF LOS ANGELES - HYPERION

Full Secondary Treatment - Year 2000 Sludge Loads

HYPERION - CLA	THICK- ENING	ANAEROBIC DIGESTION	LIQUID STORAGE	MECHANICAL DEWATERING	WET CAKE STORAGE	C-G DRYING	THERMAL PROCESSING	CHAR/ASH TRUCK	COMBINED CYCLE PLANT	TOTAL
320 dry tons per day - PS										
200 dry tons per day - WAS										
CAPITAL COST (\$000)										
LAND	0	0	0	0	0	0	0	0	0	0
PROCESS	22624	16862	8040	10785	2082	41045	30939	415	5129	137921
TOTAL CAPITAL	22624	16862	8040	10785	2082	41045	30939	415	5129	137921
TOTAL ANNUAL CAPITAL	2115	1576	751	1008	194	3836	2892	101	479	12952
OPERATIONS AND MAINTENANCE COST (\$000), TOTAL ANNUAL	1501	1449		4184		2304	1240	423	574	11675
CREDITS (\$000)										
VALUE OF ELECTRICITY							2194		4351	6545
TOTAL ANNUAL CREDITS							2194		4351	6545
NET ANNUAL O & M COST (\$000/YR)	1501	1449		4184		2304	-954	423	-3777	5130
TOTAL NET ANNUAL CAPITAL AND O & M COST (\$000/YR)	3616	3025	751	5192	194	6140	1938	524	-3298	18082
TOTAL ANNUAL COST/TON OF DRY FEED (\$/TON)	47.2	14.8	5.3	36.7	1.4	45.6	14.4	11.2	-	91.7

TABLE VI-11
ESTIMATED AIR POLLUTANT EMISSION FOR PHASE III OPTIONS
CITY OF LOS ANGELES

Year 2000 PS Plus WAS from Full Secondary Treatment

(All values in pounds per day.)

PROCESS(1)	HC AS CH ₄	CO AS CO	SO AS SO ₂	NO AS NO ₂	TSP
<u>Reasonable Planning Case</u>					
Thermal Processing	29	50	577	332	170
Combined Cycle	108	420	104	1051	49
Trucks	4	25	3	19	2
Total ⁽²⁾	145	495	685	1405	225
<u>Reasonable Worst Case</u>					
Thermal Processing	36	63	1155	1659	213
Combined Cycle	134	525	652	1314	61
Trucks	5	32	4	24	3
Total ⁽²⁾	175	620	1815	2300	280
<u>Emission Offsets from Electrical Production</u> ^(2,3)	55	60	780	660	115

- (1) All digester gas assumed to be used in the combined cycle power generation system and no IC engines used for generator and blower drives.
- (2) All values rounded up to nearest 5 lb/day.
- (3) Compensating emissions resulting from production of energy by sludge processing which would otherwise be supplied by an electrical utility.

Ground level concentrations of pollutants expected under Phase III conditions were shown in Table VI-5. No violation of ambient ground level standards is expected. Comparing Phase II with Phase III, projected ground level concentrations of air pollutants attributable to the CCP and DFTP remain about the same. Higher mass emissions under Phase III are compensated by the greater discharge volume of flue gas.

Transportation Requirements: Under the Phase III option, approximately 220 cubic yards per day of char/ash would be transported from the Hyperion Treatment Plant for disposal. Assuming such material is trucked to Lopez Canyon, approximately 2,930 round trips would be made annually resulting in a total of about 223,000 vehicle miles travelled (VMT) per year. Assuming 300 working days per year and eight hours per working day, a truck interval of about 25 minutes between trucks is calculated.

Public Facility Demands: Public facilities demands for the Phase III option are presented in Table VI-12 in terms of solid waste to be managed; liquid side-streams produced during sludge processing; cooling water requirements and potable water demands.

Sources and characteristics of these demands would be the same as described for Phase II facilities except for magnitude changes resulting from larger process loadings under the Phase III option.

Energy Production and Consumption: Electrical production and demand associated with the Phase III option is provided in Table VI-13. Also shown are the amounts of diesel fuel, isopar, and polymer consumed. Sources and demands would be the same as the Phase II facilities except for magnitude increases resulting from the larger process loadings in the Phase III options.

TABLE VI-12

PUBLIC FACILITIES DEMANDS - PHASE III
CITY OF LOS ANGELES

Year 2000 PS Plus WAS from Full Secondary Treatment

PROCESS	SOLID WASTE (WTPD) ^(a)	SIDESTREAMS (MGD) ^(b)	COOLING WATER (MGD) ^(b)	POTABLE WATER (MGD) ^(c)
WAS Thickening	0	2.4	0	0
Anaerobic Digestion	0	0	0	0.120
Mechanical Dewatering	0	2.6	0	0
Dehydration	0	0.4	5.0	(g)
Thermal Processing	160 ^(d)	0.5	6.0	0.035 ^(g)
Truck Transport	0	0	0	0
Combined Cycle	0	0	4.5	0
Char/Ash to Landfill	160 ^(d)	0	0	0
Digester Residue to Landfill	450 WTPYR ^(e)	0	0	0
Baghouse Residue to Landfill	Included as part of char/ ash	0	0	0
Flue Gas Desul- furization Scrubber Sludge	50 ^(f)	0	0	0

(a) Wet tons per day (WTPD) except as otherwise indicated.

(b) Values rounded up to nearest 0.1 million gallons per day (MGD).

(c) Values rounded up to nearest 0.005 MGD.

(d) Rounded to nearest 5 WTPD. Assumes some fixed carbon remaining in ash.

(e) Wet tons per year (WTPYR) rounded to nearest 50 WTPYR.

(f) Rounded to nearest 5 WTPD.

(g) Includes condensate makeup water for dehydration and steam turbine system associated with thermal processing.

TABLE VI-13
ENERGY PRODUCTION AND CONSUMPTION FOR PHASE III
CITY OF LOS ANGELES
Year 2000 PS Plus WAS from Full Secondary Treatment

PROCESS	ELECTRICITY PRODUCED(1,4) (KWH/DAY)	ELECTRICITY CONSUMED(1,4) (KWH/DAY)	NET ELECTRICAL PRODUCTION(1,4) (KWH/DAY)	DIESEL FUEL CONSUMED(2) (GALLONS/DAY)	ISOPAR CONSUMED(2) (GALLONS/DAY)	POLYMER CONSUMED(3) (LB/DAY)
WAS Thickening	---	23,200	-23,200	---	---	700
Anaerobic Digestion	---	39,400	-39,400	---	---	---
Mechanical Dewatering	---	13,800	-13,800	---	---	4,300
Dehydration	---	55,400	-55,400	---	1,080	---
Thermal Processing	150,300	29,300	121,000	---	---	---
Truck Transport(5)	---	---	---	150	---	---
Combined Cycle Power Generation	298,000	---	298,000	---	---	---
Sidestream Processing	---	1,000	-1,000	---	---	---
TOTAL	448,300	162,100	286,200	150	1,080	5,000

- (1) All values rounded to nearest 100 kilowatt hours per day (KWH/day).
(2) Rounded to nearest 10 gallons per day (GPD).
(3) Rounded to nearest 100 pounds per day (lb/day).
(4) Assumes all digester gas is used in combined cycle power generation (CCP).
(5) Truck transport of ash/char.

**Facilities for Los Angeles
County Sanitation Districts**

VI-38

FACILITIES FOR
LOS ANGELES COUNTY SANITATION DISTRICTS

PHASE II FACILITIES

Phase II facilities for Los Angeles County Sanitation Districts' Joint Water Pollution Control Plant will, as a minimum, be sized to accommodate all sludge from primary treatment of 330 MGD of wastewater plus the waste activated sludge from secondary treatment of 200 MGD of primary effluent. Sludge loadings for the Phase II facilities projected to be produced by the Year 2000 are given in Table VI-14.

The foregoing treatment levels have been specified in the Districts' application for waiver of secondary treatment requirements. Should additional secondary treatment be required, Phase II facilities would need to be expanded to accommodate a larger volume of waste activated sludge. A decision regarding the application for waiver of secondary treatment requirements has not yet been made. Should secondary treatment of all wastewaters be required, Phase II facilities requirements would be identical to the sludge loadings described for Phase III options.

UNIT PROCESSES

A process flow diagram for the recommended Phase II facilities is shown in Figure VI-4. All waste activated sludge (WAS) would be thickened and anaerobically digested, either separately or in combination with primary sludge (PS).

Flexibility will be provided to allow operation in either mode. If necessary to achieve a net emission increase less than 150 pounds/day, digester gas would be processed for H_2S removal and a portion combusted in a combined cycle power generation system. The latter is capable of providing electrical power for plant operation and process steam for such uses as digester heating. A portion of the digester gas will be used in existing internal combustion (IC) engines to drive pumps and may be used in boilers for supplemental digester heating and in emergency standby boilers.

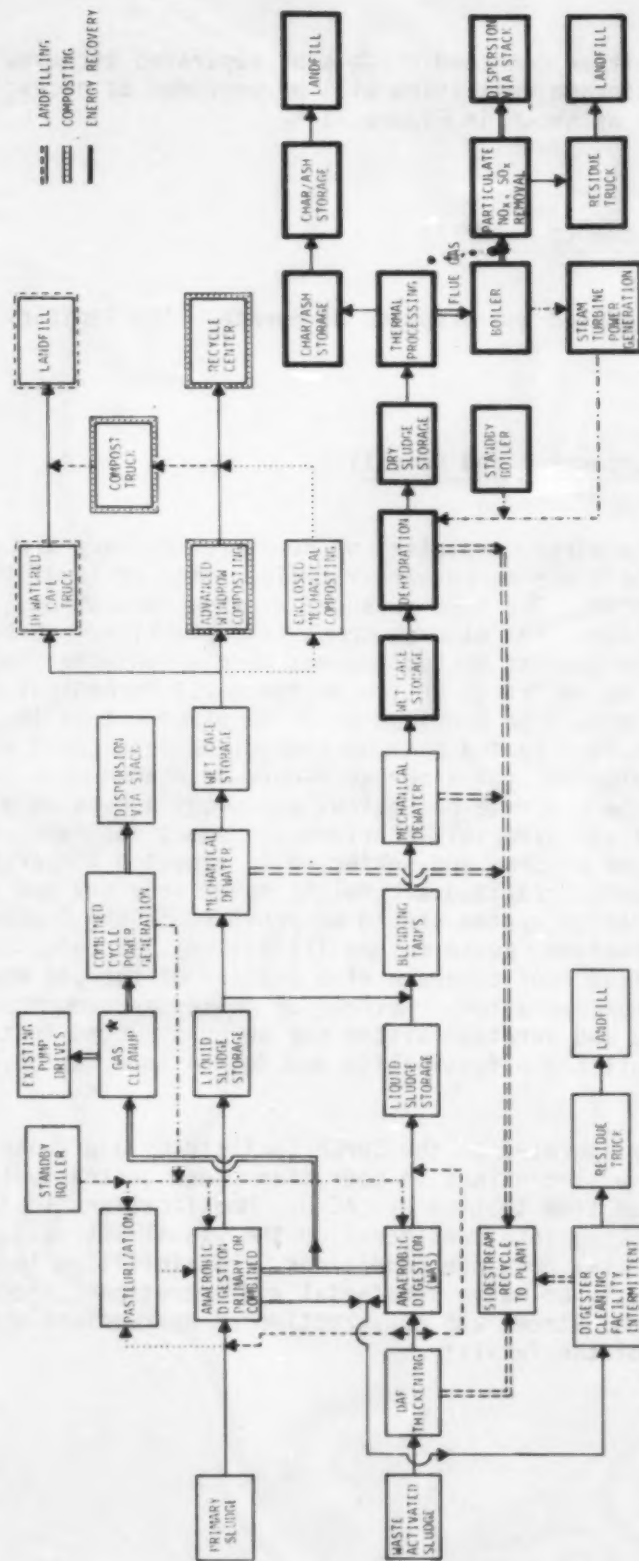
Separate liquid sludge storage is provided for digested primary sludge and digested WAS. Blending tanks are also provided to assure proper proportioning and mixing of the two sludge types prior to dewatering.

Existing mechanical dewatering facilities at JWPCP will be expanded and modified as necessary to process sludge loadings expected during Phase II. The facility

TABLE VI-14
SLUDGE LOADING ON RECOMMENDED PHASE II FACILITIES
LOS ANGELES COUNTY SANITATION DISTRICTS
Year 2000 PS Plus MGD WAS from Secondary Treatment at JWPCP

PROCESS	FEED SLUDGE RATE (DRY TONS PER DAY) (a)			REMARKS
	PRIMARY	WAS	BLEND	
Raw Sludge to Anaerobic Digestion	605	130		Primary includes effect of side-stream recycle to headworks.
Total Digested Sludge to Mechanical Dewater	395	100		
Mechanical Dewatering of Blended, Digested PS & WAS			250	Based on minimum 50:50 blend. Probable cake solids of 19 percent.
Wet Cake Storage			240	Assumes 95 percent capture in dewatering and 3-day storage.
Dehydration			240	
Dry Product Storage			240	3-Day Storage (720 dry tons)
Thermal Processing			240	Assumes any extracted heavy oil is returned to the dried product.
Char/Ash Storage			90	Assumes total fixed carbon burn-out. Would be about 115 dtpd with reduced burnout efficiency. Assume 3-day Storage (270 dry tons)
Char/Ash Truck to Landfill			90	Same as above.
Mechanical Dewatering of Digested PS	250			Probable cake solids of about 22 percent.
Wet Cake Storage	235			Assumes 95 percent capture in dewatering and 3-day Storage (720 dry tons)
Advanced Windrow Composting	100-150			Sludge loading is expected to vary throughout the year. Minimum design capacity should be 150 dtpd or higher.
Dewatered Cake to Landfill	75-150			Sludge loading is expected to vary throughout the year. Design capacity as requested by LACSD.
Enclosed Mechanical Composting Demonstration Facility				10 to 20 dtpd demonstration system is planned, but no fixed tonnage will be applied for purposes of sludge management until completion of the demonstration studies.

(a) All values rounded up to the nearest 5 dry tons per day (dtpd).



KEY

- ALTERNATE FLOWPATH
- DEMONSTRATION SYSTEM
- GAS FLOW
- LIQUID SIDESTREAM
- SLUDGE SOLIDS FLOW
- STEAM FLOW

WAS - WASTE ACTIVATED SLUDGE
 IC - INTERNAL COMBUSTION
 NO_x - OXIDES OF NITROGEN
 SO_x - OXIDES OF SULFUR
 DAF - DISSOLVED AIR FLOTATION

*IF NEEDED TO ACHIEVE A NET EMISSION INCREASE OF 150 LBS/DAY SO_x OR LESS.

PHASE II UNIT PROCESS TRAIN
LOS ANGELES COUNTY SANITATION DISTRICTS
 REGIONAL SLUDGE MANAGEMENT PROGRAM
 LOS ANGELES-ORANGE COUNTY METROPOLITAN AREA
FIG. VI-4

will be designed to process either combined sludges or separated streams. Separate conveyance and wet cake storage facilities will be provided as necessary to process in the separated mode as shown in Figure VI-4.

Train A - Truck Dewatered Sludge to Landfill

Dewatered cake will be truck hauled and disposed at Puente Hills Sanitary Landfill.

Train B - Advanced Windrow Composting and Recycling

Train B consists of advanced windrow composting of dewatered primary sludge, followed by reuse of the compost via an on-site recycle center or landfill disposal of unmarketable compost. The term advanced windrow composting embodies several improvements over conventional windrow composting practice. While actual design of the advanced windrow compost system has not been undertaken, the following elements were considered important in the design: (1) Mechanical metering and mixing of all components should be provided prior to placement in the windrow, (2) Windrows should be constructed to the maximum dimensions consistent with available compost turning equipment, (3) Windrows should be placed on a concrete pad or other hard surface. The concrete pad allows equipment access in all weather, assures easy removal of all material, provides increased assurance that all material is included in the windrow and subjected to elevated temperatures and provides better control over localized accumulations of very dry and dusty compost, and (4) A forced aeration system should be provided in the concrete pad to allow maximum windrow dimensions, avoid oxygen limitations, and provide maximum moisture removal. Fixed roof coverage of a portion of the pad may be provided to improve wet weather operation. Several of these improvements, particularly the concrete pad and aeration system may be constructed initially on a limited scale to develop full scale feasibility and design information.

A recycle center is currently operated on the JWPCP facility by a private company. Existing physical facilities will continue in operation under contractual arrangements that are negotiated from time to time by LACSD. Modifications to this facility may be necessary, taking into consideration the visual attractiveness to the local community and potential nuisance conditions. Possibilities include enclosed buildings for all dusty or odorous material and operations; increased set-back of structures from the street and construction of appropriate screening to reduce the visual impact of the facility.

Train C - Dehydration and Thermal Processing

Train C consists of dehydration of dewatered combined PS and WAS followed by thermal processing of the heat dried product.

A number of different sludge blends of PS and WAS are possible depending on the operating modes determined as most optimum. Two likely possibilities are to combine all sludges prior to digestion or to maintain separate digestion and blend digested sludges (at point A on Figure VI-4) on a 50-50 basis by dry weight. This ratio has been determined as a reasonable minimum for efficient dewatering of WAS. Since the ability to handle WAS is a key feature of the recommended management plan, and since the system is efficient in handling wet sludges, a 50-50 blend of digested PS and WAS at point A has been assumed for sizing of the Phase II dehydration and thermal processing train. It should be understood, however, that the system is not tied to this mode of operation, but rather is flexible and can respond to various sludge blends.

Sizing on the basis of a 50-50 blend of digested PS and WAS represents a reasonable minimum, below which the ability to manage WAS may be impaired. However, other concerns, such as prospects for long term federal-state construction grant assistance and future availability of landfills, may also affect Phase II facility sizing. Therefore, the size of the dehydration-thermal processing train may increase during the design phase of the project in response to these concerns.

The dehydration process includes subsystems designed for fluidizing oil storage, sludge/oil mixing, sludge/oil grinding, multiple effect evaporation, deoiling, hydroextraction, heavy oil extraction, condensate clean-up, and pelletizing of the hydroextracted product. Dried product from the dehydration process will be thermally processed for energy recovery. Energy from combustion will be extracted in a waste heat boiler. Steam will be used for electrical power generation in a steam turbine and for process applications in the dehydration process. Char and ash produced during thermal processing will be truck hauled to Puente Hills landfill for disposal.

An advanced air cleanup train will be used to reduce emissions of particulates, NO_x and SO_x . Systems to accomplish pollutant reduction will include baghouses or equivalent for particulate removal, NO_x reduction using ammonia injection, and SO_x removal by wet scrubbing or wet scrubbing augmented by lime addition. Wet scrubbing will also be necessary to reduce the flue gas temperature for steam plume suppression. Flue gases will be directed through a stack for atmospheric dispersion. At this time, stack height is expected to be between 50 and 100 feet (above ground level) to provide dispersion of exhaust gases. Residues from the air cleanup equipment, such as dusts or lime sludges, will be truck hauled to a landfill for ultimate disposal.

Liquid sidestreams produced during sludge processing will be recycled back to the treatment plant. It is common to return such sidestreams to the plant headworks. However, other return points are possible and may, in some cases, be desirable to achieve better plant operation. Whatever the case, final effluent discharge limitations will not be exceeded.

Storage

Intermediate storage facilities will be provided at four points: (1) separate liquid sludge storage for digested primary and digested WAS, (2) wet cake storage following mechanical dewatering, (3) dried pelletized sludge storage following dehydration, and (4) char/ash storage following thermal processing. Temporary storage for about 3 days is envisioned for wet cake, dried sludge and char/ash. For liquid sludge a 24-hour holding period will be provided. Sizing of storage facilities will be finalized during detailed facilities design.

Stand-by Capacity

The dehydration/thermal processing system will be designed on a modular basis. As a minimum, three modules will be provided, any two of which are capable of processing the design sludge loading for Train C. Other modular arrangements which provide the same level of reliability and flexibility may be found during the detailed design of facilities. However, a minimum of one module will be provided for standby purposes. Standby boiler capacity will also be provided for use in the event of steam supply interruption.

The intermediate storage facilities shown in Figure VI-4 represent additional backup in the event of temporary process shutdown. As such, the storage facilities are an essential element of the total process train and add to system reliability.

Prolonged wet weather conditions are potentially disruptive with respect to the composting process and landfilling of dewatered sludge. The advanced windrow composting design will incorporate measures to improve resistance to wet weather disruptions. The standby dehydration/thermal processing capacity will also be used as necessary during wet weather to relieve sludge loading on the landfill and composting operations. Improvements in landfill operations, such as purchase of additional equipment and development of revised operational procedures, will be made during wet weather periods to improve reliability of sludge management. Design of these systems will be based upon reasonable probabilities of occurrence of prolonged rainfall conditions.

Under the design concepts described above and using data from Table VI-14, maximum operating capacity of the dehydration/thermal processing system would be about 360 dry tons per day. Additionally, storage for a total of 1,440 dry tons of dewatered sludge is provided in the total system. For purposes of analysis it is assumed that: (1) full operating capacity of the dehydration/thermal processing system would be used from the onset of a prolonged rainfall period, (2) dewatered sludge storage would be used to the maximum extent practicable during a prolonged rainfall period, (3) the landfill would continue to receive a minimum of 75 dtpd of dewatered sludge during a prolonged rainfall period, (4) as necessary, the compost process would not receive any dewatered sludge from the onset of a prolonged rainfall period, and (5) the system is designed so that sludge can be removed from wet cake storage facilities and trucked to a landfill.

Demonstration Facilities

Two large scale demonstration systems will be evaluated to provide technological capability for increased flexibility to meet changing environmental, regulatory, or social constraints. Because these facilities are demonstration in nature, provision has been made to accommodate all sludge in primary parts of the system to assure that adequate sludge management capability is provided at all times.

● Enclosed Mechanical Composting

LA/OMA public participation results indicate that increased awareness on the part of treatment plant neighbors and regulatory agencies will require increased efforts to control odors, nuisances, and pathogens. An enclosed mechanical composting reactor offers considerable potential for improved operational stability, increased statistical reliability for pathogen destruction, and increased control over odor and dust nuisances. A modest scale facility sized for about 10 to 20 dtpd capacity will be constructed to verify this technology. The facility will include the following design elements (1) mechanical metering and mixing of all materials into the composter; (2) an enclosed reactor capable of providing a high level of agitation and forced aeration; (3) collection, deodorization and dispersion of exhaust gases from the reactor; (4) pelletization of a portion of the reactor outfeed to investigate potential for reducing dust nuisances; (5) heat drying for a portion of the reactor outfeed to investigate the potential for reduced dependence on air drying, particularly during winter months; and (6) a high degree of dust control. Finished compost would be marketed or land-filled as indicated by quality control results and regulatory constraints.

● Pasteurization

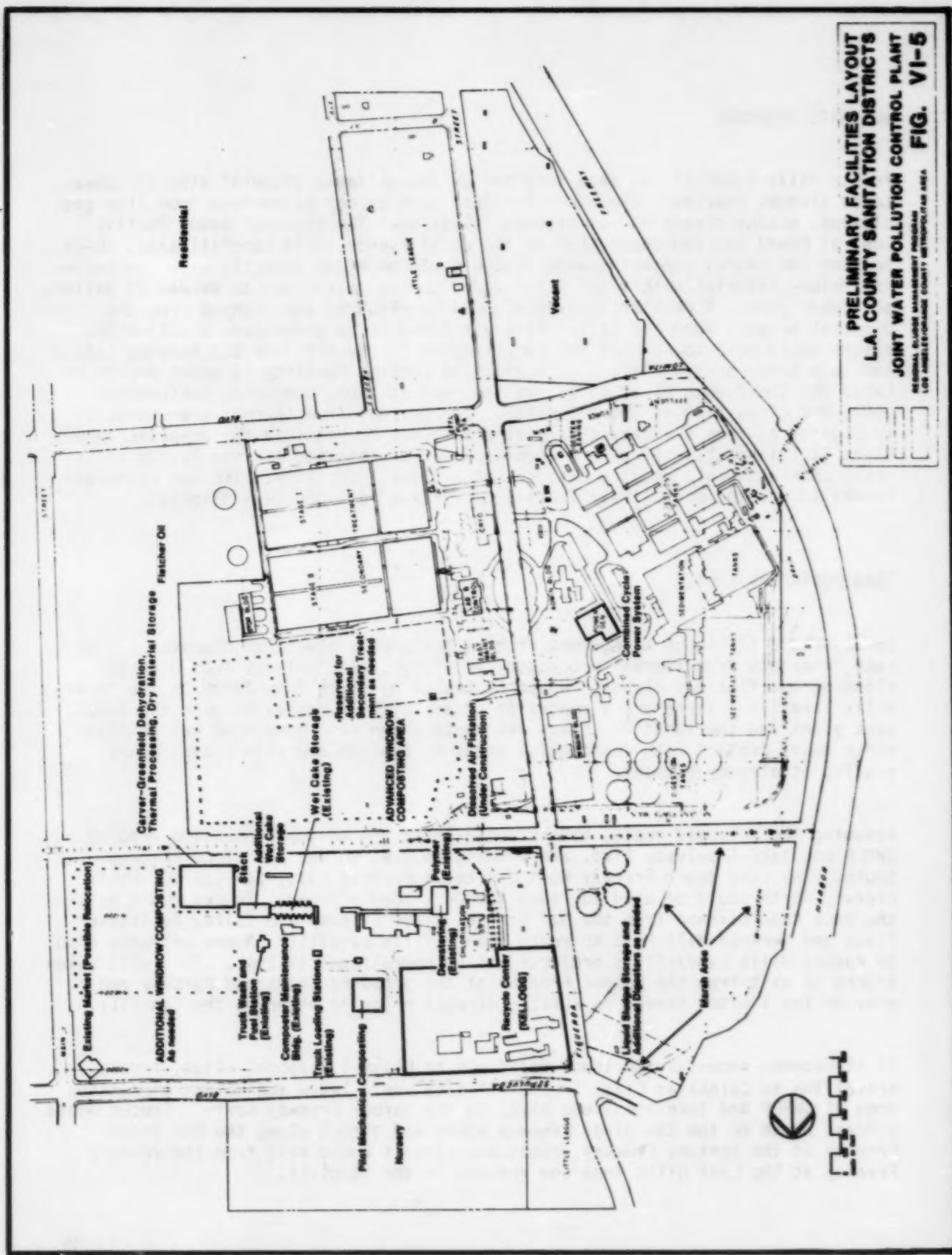
Pasteurization would be needed if the improved windrow composting operation is unable to adequately control pathogens in the compost. The technology for heat pasteurization developed during Phase II to allow flexibility to meet changes in quality standards. A demonstration facility sized to accommodate one full scale digester will be undertaken equivalent to about 40 dtpd capacity. Studies to date indicate that pasteurization can be achieved with little or no increase in energy consumption compared to that needed for conventional digester heating.

SITE LAYOUT

Preliminary location of onsite facilities for sludge processing are shown in Figure VI-5. The facilities at JWPCP include dissolved air flotation, anaerobic digestion, liquid sludge storage for digested primary sludge, separate liquid storage for digested WAS, blending tanks, sludge dewatering facilities, wet cake storage facilities, dehydration, dehydrated sludge storage, thermal processing with energy recovery and air clean-up systems, char/ash storage, combined cycle power generation, pilot mechanical composting, advanced windrow composting, recycle center facilities, sludge cake and compost mixing station, truck loading facilities for sludge cake and residue hauling to landfill. Some of the facilities are existing, including most of the anaerobic digesters and dewatering and polymer feed buildings, the wet cake storage and truck loading station. Digestion, dewatering, and wet cake storage facilities are expected to be expanded, and the recycle center area would also be remodeled as indicated by project evaluation. Other facilities would be new construction undertaken under Phase II.

The marsh area shown in Figure VI-5 has been the focus of an LACSD commitment to its protection. The position of the Sanitation Districts is that development of the marsh property would occur only if absolutely necessary, in keeping with EPA's Wetlands Policy (Ref. 9). As the marsh area is an important environmental resource, LACSD has reconfirmed its commitment.

The JWPCP property may contain archaeological artifacts west of Figueroa Street and north of the railroad tracks. LACSD has indicated its commitment to provide adequate protection for any archaeological resources. Prior to any on-site engineering and/or geological surveys, an archaeological investigation(s) by a qualified archaeologist (listed by the Society of Professional Archaeologists) will determine the significance of all archaeological artifacts. Appropriate measures of protection will be applied.



ULTIMATE DISPOSAL

Puente Hills landfill has been selected as the ultimate disposal site for dewatered sludge, char/ash, and other residues such as may be derived from flue gas cleanup, sludge screening, or digester cleaning. The Regional Water Quality Control Board has indicated that at the LACSD Puente Hills Landfill site, 80-85 percent (moisture) content sewage sludge could be mixed directly with the incoming refuse material with total water added to the refuse not to exceed 25 gallons per cubic yard. A monitoring system would be required down-canyon from the disposal areas. When and if leachate was found to be generated, a collection system would have to be used for recycling to the landfill or discharging into a sanitary sewer system (Ref. 1). A leachate control facility is under design by LACSD for the Puente Hills site. At the present time, community incinerator ashes are classified as Group I waste. If char/ash from thermal processing is considered a Group I waste, a special permit may be required for disposal to a Class II-1 landfill. If such a permit cannot be obtained for the Puente Hills site, char/ash would require disposal at a Class I facility. BKK and Calabasas Landfills are the most likely Class I facilities for long-term disposal.

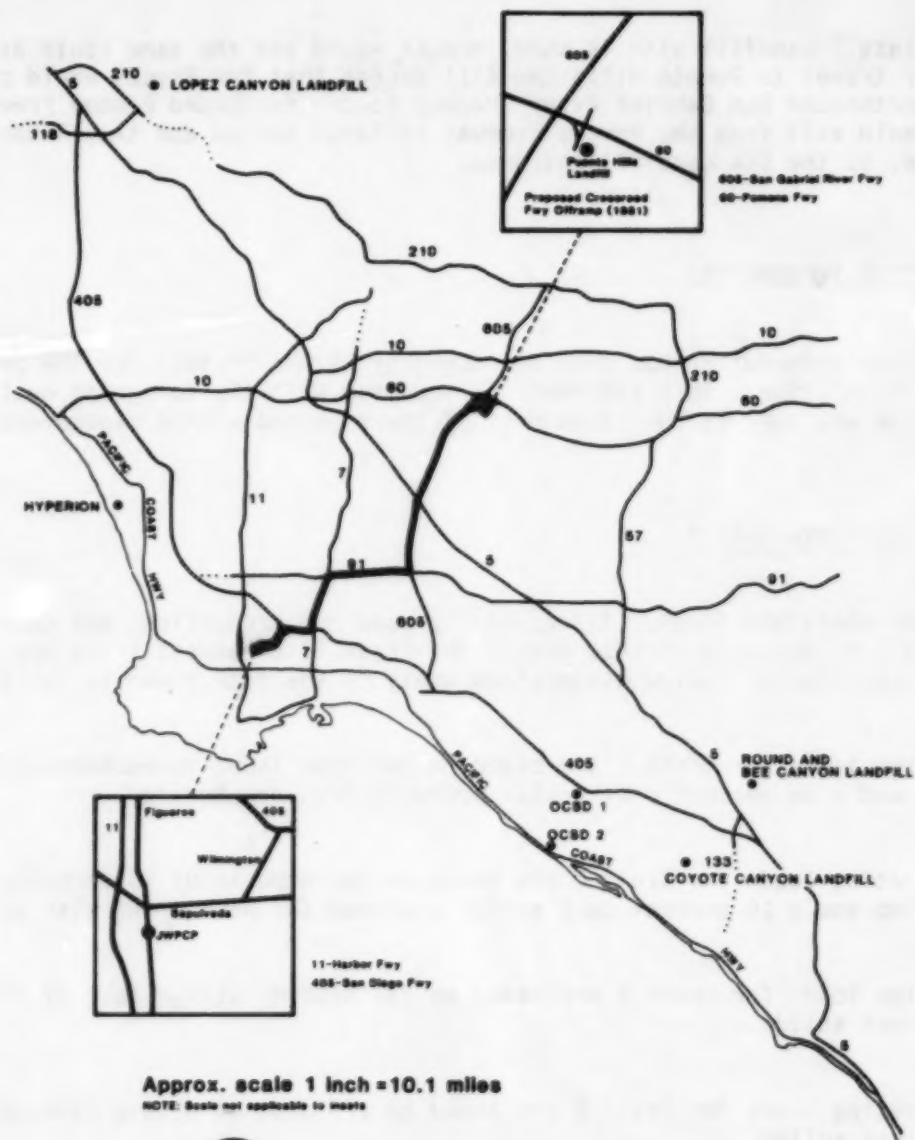
TRANSPORTATION ROUTES

In the Phase II Sludge Management Program for LACSD, dewatered digested sludge cake, char/ash from thermal processing of sludge, and residues from digester cleaning and flue gas cleanup, would be hauled by truck from JWPCP to the Puente Hills landfill. There are a number of possible truck routes between the treatment plant and the landfill site. The route shown in Figure VI-6 was selected, since major contact with residential areas is avoided and significant truck traffic is already present.

Assuming the selected route, trucks would leave the solids processing area at JWPCP and take Sepulveda Blvd. and Wilmington Ave. to the San Diego Freeway South. The Long Beach Freeway North, Artesia Freeway East, San Gabriel River Freeway North would be used to reach the Peck Road offramp. Trucks would exit the Peck Road offramp from the San Gabriel River Freeway and follow Pellissier Place and Workman Mill Road to reach Puente Hills Landfill. A new entrance road to Puente Hills Landfill is projected to be operational in 1981. This will allow trucks to exit from the Pomona Freeway at the proposed Crossroad Parkway and provide for limited travel on surface streets prior to entering the landfill.

If it becomes necessary to truck residuals to Class I disposal sites, trucks travelling to Calabasas Class I Landfill site would leave the solids processing area at JWPCP and take Sepulveda Blvd. to the Harbor Freeway North. Trucks would proceed north to the San Diego Freeway North and thence along the San Diego Freeway to the Ventura Freeway westbound. Trucks would exit from the Ventura Freeway at the Lost Hills Road and proceed to the landfill.

LACSD



NOTE: Numbers correspond to freeways



If BKK Class I Landfill site is used, trucks would use the same route as designated for travel to Puente Hills Landfill except that the trucks would continue on the northbound San Gabriel River Freeway to the eastbound Pomona Freeway. Trucks would exit from the Pomona Freeway at Azusa Avenue and travel north on Azusa Ave. to the BKK Landfill entrance.

QUANTITATIVE INFORMATION

Quantitative information has been developed by LA/OMA Project for the proposed Phase II facilities. This information, together with the foregoing qualitative description was used in the assessment of the proposed sludge management program.

Economic Characteristics

Design and operating loads, sizing, energy used and production, and capital and O & M costs for each unit process within the Phase II treatment train are shown in Table VI-15. The following assumptions apply to the data shown in Table VI-15.

- Design loads for Train C are based on 250 dtpd input to mechanical dewatering and a 16 percent cake solids produced from dewatering.
- Operating loads for Train C are based on 250 dtpd input to mechanical dewatering and a 19 percent cake solids produced for dewatering with polymer.
- Design loads for Train B are based on 150 dtpd of sludge cake at 22.5 percent solids.
- Operating loads for Train B are based on 120 dtpd of sludge cake at 22.5 percent solids.
- Design loads for Train A are based on 150 dtpd of sludge cake at 22.5 percent solids.
- Operating loads for Train A are based on 120 dtpd of sludge cake at 22.5 percent solids.
- Costs for mechanical dewatering are based on dewatering 499 dtpd of combined digested PS and digested thickened WAS, with 11 lb/ton polymer, and 95 percent capture.

TABLE VI-15

QUANTITATIVE CHARACTERISTICS OF PHASE II FACILITIES
SIZING, ENERGY, AND COSTS

Los Angeles County Sanitation Districts - Joint Water Pollution Control Plant

	THICK- ENING	ANAEROBIC DIGESTION	LIQUID STORAGE	MECHANICAL DEWATERING	WET CAKE STORAGE	C-G DRYING	THERMAL PRO- CESSING	CHAR/ ASH TRUCK	WET CAKE TRUCK	ADV. WIND. COMPOST.	SLUDGE RECYCLE CENTER	COMBINED CYCLE PLANT	TOTAL
587 dry tons per day - PS													
128 dry tons per day - WAS													
DESIGN LOADING (dry tons/day) ^a .													
(*tons of H ₂ O/day)	135	740	499	499	437	1250*	238	132	150	150	-	-	715
OPERATING LOAD ^b .													
(dry tons/day)	135	740	499	499	437	1015*	238	88	120	120	82		715
(*tons of H ₂ O/day)													
SIZING													
LAND AREA REQUIRED (acres)	0.5	2.9	0.7	2.6	0.5	0.8	1.3		-	21.0	0.7	0.3	31.3
EMPLOYEES													
(No. per 24 hrs)	5	18		18		8	5	2	11	9		9	86
POLYMER USED (lbs/day)	404	-		5489									5893
ISOPAR L USED (gal/day)						700							700
O ₂ FOR RECYCLE (tons/day)				2.3		1.2							3.5
ENERGY													
ELECTRICITY USED (KWH/DAY)	13474	48881		20867		33495	18304			259			135280
ELECTRICITY PRODUCED (KWH/DAY)							95520					386400	481920
FUEL OIL USED (gal/day)													
FUEL PRODUCED (tons/day)													
DIESEL FUEL USED (gal/day)								97	383	558			1038
O ₂ FOR RECYCLE (KWH/DAY)						375							1091

(a) Design load refers to the tonnage of solids or water used for estimation of capital costs.

(b) Operating load refers to the tonnage of solids or water used for estimation of O & M costs.

TABLE VI-15 (Continued)

QUANTITATIVE CHARACTERISTICS OF PHASE II FACILITIES
SIZING, ENERGY, AND COSTS

Los Angeles County Sanitation Districts - Joint Water Pollution Control Plant

JOINT WATER POLLUTION CONTROL PLANT - LACSD	THICK- ENING	ANAEROBIC DIGESTION	LIQUID STORAGE	MECHANICAL DEWATERING	WET CAKE STORAGE	C-G DRYING	THERMAL PRO- CESSING	CHAR/ ASH TRUCK	WET CAKE TRUCK	ADV. WIND COMPOST	SLUDGE RECYCLE CENTER	COMBINED CYCLE PLANT	TOTAL
587 dry tons per day - PS													
128 dry tons per day - WAS													
CAPITAL COST (\$000)													
LAND	0	0	0	0	0	0	0	0	0	0	0	0	0
STRUCTURAL				3594		2507	3073					347	9521
PROCESS		13918	3565	12275	5595	32176	24462	450	1434	10758		8933	113566
TOTAL CAPITAL		13918	3565	15869	5595	34783	27535	450	1434	10758		9280	123087
TOTAL ANNUAL CAPITAL		1301	333	1483	523	3242	2574	109	349	1033		867	11814
OPERATIONS AND MAINTENANCE COST (\$000)													
LABOR	302	905		982		402	251	101	520	362		452	4277
DIESEL FUEL								23	87	133			243
FUEL OIL										4			1921
ELECTRICITY	197	659		305		489	267						4302
POLYMERS	295			4007									383
ISOPAR L						383							2810
MAINTENANCE	26	168		445		973	772	22	140	4		260	39
RECYCLE OXYGEN				25		14							680
DUMP CHARGE								96	584				
TOTAL ANNUAL O & M	820	1732		5764		2261	1290	242	1331	503		712	14655
CREDITS (\$000)													
SALE OF COMPOST											-86	-86	-86
VALUE OF FUEL		-499										-499	-499
VALUE OF ELECTRICITY							-1395					-5641	-7036
TOTAL ANNUAL CREDITS							-1395				-86	-5641	-7621
NET ANNUAL O & M COST (\$000/YR)	820	1732		5764		2261	-105	242	1331	503	-86	-4929	7533
TOTAL ANNUAL CAPITAL AND NET O & M COST (\$000/YR)	820	2534	333	7247	523	5503	2469	351	1680	1536	-86	-4062	18848
TOTAL ANNUAL COST/TON OF DRY FEED (\$/TON)	16.6	9.4	1.8	39.8	3.3	63.3	28.4	10.9	38.4	35.1	-86		72.2

c. Structural cost included in process cost.

- Capital costs for all unit processes shown in Figure VI-4 are included with the exception of capital costs for DAF thickening which has already been committed for construction by LACSD. Existing digester capacity was assumed to be $8.7 \times 10^6 \text{ ft}^3$ which includes 6 circular digesters committed for construction by LACSD in 1979. Capital cost for digestion reflects only additional digester requirements.
- Liquid digested sludge storage for 1 day and wet cake storage for 3 days are provided for the entire sludge flow. Capital costs for wet cake storage reflects only the additional storage requirements beyond that already available at JWPCP.
- O & M costs for liquid and wet cake storage are included in the O & M cost for anaerobic digestion and mechanical dewatering, respectively. Three day storage for both dehydrated product and char/ash is also provided with capital and O & M costs included in dehydration and thermal processing, respectively.
- Three modules of the dehydration and thermal processing systems are provided with any two modules capable of handling the design sludge load of 250 dtpd at 16 percent solids.
- Costs for energy recovery, flue gas desulfurization, selective non-catalytic NO_x reduction, and flue gas particulate removal are included in the cost of thermal processing.
- About 456 mm BTU/day of digester gas is used in existing IC engine pump drives. No capital or O & M costs are assigned to the IC engines, but use of the digester gas is valued at \$3/mm Btu.
- The combined cycle power system is sized for the total projected digester gas production (less that used in IC engines). Steam extracted from the steam turbine is assumed to be used for digester heating.
- Energy in flue gases produced during thermal processing is converted to steam in a waste heat boiler. The steam is converted to electrical power in a steam turbine with a portion of the steam extracted and used for process applications in the dehydration system.
- The cost factors in Table VI-1 are applicable.
- New structures are included in the capital costs for mechanical dewatering, dehydration, thermal processing, and the combined cycle plant.

LACSD

Based on these assumptions, a total capital cost of \$123,087,000 is estimated, which is equivalent to \$11,814,000/yr. Total annual O & M is estimated at \$14,655,000/yr with credits for the value of fuel, electricity, and compost produced at \$7,621,000/yr. The net cost, defined as annual capital plus O & M less credits, is about \$18,848,000/yr. The latter is equivalent to about \$72.2/dry ton of raw sludge processed through the system.

Air Pollutant Emissions

Air pollutant mass emission estimates are shown in Table VI-16 for the Phase II facilities that would be located at the Los Angeles County Sanitation Districts' Joint Water Pollution Control Plant.

The proposed sludge management facilities will result in net production of surplus electrical power which will be used primarily to satisfy electrical power requirements for wastewater treatment. If such surplus power were not produced from sludge processing, the electricity required for wastewater treatment would be purchased from electrical utilities. Therefore, compensating emission offset reductions, equal to the air emissions expected to occur from a Southern California utility using fuel oil to produce electricity equivalent to the net surplus electricity from sludge processing, have been calculated and are shown in Table VI-15.

Air pollution emission estimates have been developed by the LA/OMA Project from application of unit emission factors shown in Chapter VII. Factors for total suspended particulates (TSP), nitrous oxide (NO_x), sulfur oxides (SO_x), hydrocarbons (HC), and carbon monoxide (CO) through literature reviews, field and laboratory testing and consultations with manufacturers, air quality regulatory and planning agencies, and private consultants.

The Los Angeles County Sanitation Districts have filed with the South Coast Air Quality Management District applications to construct and operate a combined cycle turbine power generation system and a dehydration and thermal processing system. Action on the application has not been completed.

Air pollutant mass emissions have been developed for two cases. Use of these two cases in the environmental impact analysis assures that a range of potential impacts is identified and effects of uncertainty associated with development of the emissions estimates would be minimized. LACSD will conduct pilot studies of fluid bed desulfurization to obtain more information regarding air emissions that might be realized from the proposed facilities.

The "reasonable planning case" has been defined based upon use of sophisticated air emission control equipment and operation of such equipment at the design

TABLE VI-16

ESTIMATED AIR POLLUTANT EMISSION RATES FOR PHASE II FACILITIES
LOS ANGELES COUNTY SANITATION DISTRICTS

Year 2000 PS Plus WAS from 200 MGD Secondary Treatment

(All values in pounds per day.)

SCENARIO CASE	HC AS CH ₄	CO AS CO	SO ₂ AS SO ₂	NO _x AS NO ₂	TSP
UNIT PROCESS					
1978 BASE EMISSIONS (2,4)	1935	605	90	4765	135
TWO MODULE					
Reasonable Planning Case					
Thermal Processing	18	32	361	208	106
Char/Ash Truck	3	17	2	13	1
Wet Cake Truck	10	66	8	50	5
Windrow Composting (1)	15	96	11	73	8
Combined Cycle	139	545	41	1363	64
IC Engines	638	196	4	1550	41
Total (2)	825	955	430	3260	225
Reasonable Worst Case					
Thermal Processing	22	39	722	1038	133
Char/Ash Truck	3	21	3	16	2
Wet Cake Truck	13	83	10	62	7
Windrow Composting (1)	19	121	14	91	10
Combined Cycle	174	681	253	1703	79
IC Engines	638	196	25	1550	41
Total (2)	870	1145	1030	4460	275
Emission Offsets From Electrical Production (2,3)	65	70	940	795	140
THREE MODULE					
Reasonable Planning Case					
Thermal Processing	26	46	527	303	155
Char/Ash Truck	4	26	3	20	2
Wet Cake Truck	5	33	4	25	3
Windrow Composting (1)	8	48	6	36	4
Combined Cycle	139	545	41	1363	64
IC Engines	638	196	4	1550	41
Total (2)	820	895	585	3300	270
Reasonable Worst Case					
Thermal Processing	33	57	1053	1513	194
Char/Ash Truck	5	33	4	25	3
Wet Cake Truck	7	41	5	31	3
Windrow Composting (1)	8	48	6	36	4
Combined Cycle	174	681	253	1703	79
IC Engines	638	196	25	1550	41
TOTAL (2)	865	1060	1350	4860	325
Emission Offsets From Electrical Production (2,3)	65	75	985	835	145

(1) Emissions are from windrow turning devices.

(2) Values rounded up to the nearest 5 pounds per day (lb/day).

(3) Compensating emissions resulting from production of electrical energy by sludge processing which would otherwise be supplied by an electrical utility.

(4) Includes only emissions from onsite operation of IC engines and boilers. A portion of the digester gas is used offsite by an adjacent oil refinery. Emissions from offsite uses of digester gas were not included to assure that the analysis would be conservative. Inclusion of such emissions would increase the 1978 Base inventory.

removal efficiencies. Specific assumptions underlying the "reasonable planning case" are (1) 80 percent removal of hydrogen sulfide from digester gas prior to combustion, (2) selective catalytic reduction to achieve 90 percent removal of NO_x in flue gas from the thermal processing reactor, (3) fabric filters for particulate removal to achieve a particulate concentration of 0.01 grains per actual cubic foot at 400°F in the flue gas from thermal processing, (4) flue gas desulfurization to achieve a concentration of 0.221 pounds per ton-wet basis (a concentration of about 50 ppm(v)) in the flue gas from the thermal processing reactor, and (5) other emission factors as shown in Table VII-5.

The "reasonable worst case" has been defined based upon the assumption that air emission cleanup equipment would function at less than design efficiencies and in some instances, inclusion of lower levels of control. Complete failure of a process or its associated air emission control system was not included since the modular design of most systems would include standby capacity for sludge processing and air emission controls. Specific assumptions underlying the "reasonable worst case" are (1) no removal of hydrogen sulfide from digester gas, (2) flue gas desulfurization achieves 100 ppm (v) in the flue gas from the thermal processing reactor, (3) use of selective non-catalytic reduction to achieve 50 percent NO_x removal in flue gas from thermal processing, and (4) other emission factors shown in Table VII-5 (excluding those for reciprocating engines and electrical utility power generation) are increased by 25 percent, including the hydrogen sulfide content of digester gas.

Air pollutant mass emission estimates are also presented for two operating scenarios. The "two module" scenario is defined based upon a 250 dtpd loading on the dehydration and thermal processing facilities included in Train C of the Phase II facilities. The "three module" scenario is based upon a 375 dtpd loading on the dehydration and thermal processing facilities. Thus the "two module" scenario would represent operation of two of the three modules that would be provided while the "three module" scenario would involve operation of all three modules. In both scenarios, a portion of the digester gas would be used in existing internal combustion engines (IC) to operate pumps. Thus, emission estimates are provided which describe the full range of maximum operating capacity.

The foregoing estimates are not meant to imply that lower emission levels are not attainable. There is good evidence that lower particulate and sulfur dioxide emissions from thermal processing would be achievable with application of innovative techniques and control systems (Ref. 2). It is also recognized that selective catalytic NO_x reduction systems have not been reliably demonstrated in applications involving solid fuels. On the other hand, there appear to be good prospects that non-selective catalytic NO_x reduction systems can achieve greater than 50 percent removal efficiencies in the type of application envisioned by the proposed sludge management project. Questions of this nature should be resolvable by incorporation of any needed mitigation measures (if the environmental analysis based upon the range of air pollutant mass emissions given in Table VI-16 discloses significant adverse impacts) and during design of facilities.

Referring to Table VI-16 for the two module case and comparing to 1978 estimated emission levels, emission reductions for HC and NO_x are projected. Emission levels for CO and TSP will increase slightly. A larger increase in the mass emission rate for SO_x is predicted. Furthermore, the extent of the increase in SO_x is largely dependent on whether the design case or worst case is considered. It should be noted that if 90 percent H_2S removal were achieved from digester gas and a final flue gas SO_2 concentration of 25 ppm (v) from thermal processing, the mass emission rate for SO_2 would be about 225 lb/day, which is only a slight increase over 1978 estimated levels.

Similar comments apply to the three module case where 375 dtpd is processed in Train C. However, a slight increase in NO_x is predicted under the reasonable worst case assumption. Again, the largest increases are noted for SO_x .

The Phase II facilities will result in the net production of electrical power which will be used primarily to satisfy wastewater treatment requirements. If power were not produced from sludge processing, electricity required for wastewater treatment would have to be purchased from electrical utilities. Therefore, emission offsets equal to the air emissions expected from a Southern California utility using fuel oil to produce an equivalent amount of net electricity are shown in Table VI-16. The emission offset for SO_x is quite significant. When compared to the reasonable design case, an actual reduction in SO_x mass emission rate is predicted, with nearly equivalent levels for the reasonable worst case. Therefore, if electrical offsets are considered and reasonable design conditions achieved, Phase II facilities will result in reductions in HC and NO_x and SO_x for 1978 base conditions, and nearly equivalent mass emission rates for CO and TSP.

LA/OMA Project information (Ref. 2) shows that planning case emission levels can be achieved in all cases with the possible exception of catalytic NO_x reduction from thermal processing. Thus, projected NO_x emissions from thermal processing appear to be closer to the reasonable worst case level. In some cases, including particulate and SO_x control on flue gas from thermal processing, more stringent emission controls may be achievable. Direct SO_x emissions will depend largely on whether H_2S is removed from digester gas prior to combustion. Direct SO_x emissions greater than the reasonable planning case would result if H_2S is not removed from digester gas, or equivalent SO_x reductions not achieved from other in-plant sources. The following direct project emissions are projected assuming reasonable planning case emissions for HC, CO, and TSP; planning case emission levels for NO_x , except for thermal processing where reasonable worst case emissions are assumed; and reasonable planning case emissions for SO_x , both with and without H_2S removal.

Two Module Scenario

HC 825 lb/day

CO 955 lb/day

SO_x 610 lb/day (No H₂S removal), 430 lb/day (with H₂S removal to 80 percent efficiency).

NO_x 4090 lb/day

TSP 225 lb/day

Three Module Scenario

HC 820 lb/day

CO 895 lb/day

SO_x 765 lb/day (no H₂S removal), 585 lb/day (with H₂S removal at 80 percent efficiency).

NO_x 4510 lb/day

TSP 270 lb/day

As stated above, opportunities exist to further reduce direct air emissions resulting from the Phase II facilities. In some cases these emission reductions are achievable with application of innovative control techniques which may not be entirely proven in facilities of a similar nature. The following control measures are available to further reduce direct project emissions and are judged to have a high probability of successful application.

- Increased efficiency of particulate removal from the thermal processing flue gas. (Potential reduction of about 100 lb/day and 145 lb/day for 250 and 375 dtpd cases respectively. Based on achieving 0.0005 gr/ACF in flue gas.)
- Increased efficiency of H₂S removal from digester gas prior to combustion. (Potential reduction of about 20 lb/day SO_x as SO₂ compared to reasonable planning case and 200 lb/day compared to no H₂S removal. Based on 90 percent removal efficiency.)
- Increased efficiency of flue gas desulfurization (FGD) from the thermal processing system. (Potential reduction of 215 lb/day SO_x as SO₂ and 315

lb/day for 250 and 375 dtpd cases respectively. Based on 20 ppm(v) in flue gas.) Greater reductions can be achieved with lower outlet SO_x concentrations.

- Water injection for NO_x control in the CCP. (Potential reduction of about 770 lb/day NO_x as NO_2 . Based on 0.13 lb NO_x /mm BTU of fuel consumed.)
- Operation of the thermal processing reactor in a uniform, steady-state manner to realize the optimum removal efficiency, possible from selective non-catalytic NO_x reduction. (Potential reductions of 205 to 415 lb/day NO_x as NO_2 from reasonable worst case for 250 dtpd. Potential reductions of 305 to 605 lb/day from reasoned worst case for 375 dtpd. Based on 60 and 70 percent removal efficiencies.)
- Selective catalytic or non-catalytic NO_x control on flue gas from the combined cycle power plant. (Potential reductions of 680 to 1230 lb/day NO_x as NO_2 compared to reasonable design case. Based on 50 and 90 percent removal efficiencies.)
- Replacement of all internal combustion engines by the combined cycle facility. (See Table VI-16 for potential magnitude of emission reductions.)

Incremental increases in ground level concentrations of oxides of nitrogen (NO_x), oxides of sulfur (SO_x), particulated (TSP), carbon monoxide (CO), and hydrocarbons (HC) were estimated for the proposed Phase II Facilities and the Phase III Options.

Ground level concentrations were estimated using the standard Gaussian dispersion model and calculation procedures described by Turner and Budney (Ref. 3,4). Stack heights and exhaust gas temperature and velocities consistent with good engineering practice were assumed. A number of wind speeds were examined in the analysis. Assumptions used in the development of ground level concentrations are:

- Gaussian dispersion model using Pasquill-Gifford dispersion coefficients. Maximum centerline concentrations used in the analysis.
- Atmospheric stability class "D" as recommended by staff of the South Coast Air Quality Management District. (Ref. 5)
- Stack heights of (1) thermal processing, 100 feet; (2) combined cycle plant, 50 feet; and (3) internal combustion engines, 30 feet.

- Plume rise calculation using Brigg's Formula.
- Velocity of stack discharges -- 50 feet per second (15.2 meters per sec.)
- Flue gas exhaust temperature of (1) thermal processing, 175°F; (2) combined cycle plant, 250°F; and (3) internal combustion engines, 750°F.
- Critical wind speed (wind velocity resulting in maximum centerline ground level concentration).
- A "high" wind case based upon the average of the highest four mean hourly wind speeds for all directions and a "low" wind case based upon the average of the lowest four mean hourly wind speeds.
- Wind speed data taken during 1956-76 for the Long Beach Airport.

Only stationary sources were included in the analysis. Although emissions from mobile sources are a significant regional problem, analysis indicates that the levels associated with the proposed facilities will not be substantial at the local level, since projected mass emission rates are small and will be widely dispersed. Construction emissions were not included because substantial long-term emissions are not anticipated.

Estimated incremental 1-hour ground level increases for the reasonable worst case emission levels are shown in Table VI-17. The concentrations shown are maximum centerline ground level concentrations separately calculated for each discharge point. Values are shown for internal combustion engines (IC), and boilers combined cycle powerplant (CCP), and thermal processing reactor (DFTP). Estimates are given for concentrations resulting from thermal processing of 250 dtpd (two module scenario) and 375 dtpd (three module scenario) of dehydrated sludge.

Ground level increments estimated for the individual point sources are not directly additive since the indicated concentrations do not usually occur at the same location. Distance from the source to the maximum centerline concentration varies significantly depending upon the characteristics of the discharge. In addition, ground level concentrations decrease rapidly with increasing lateral distance from the plume centerline. Thus it is unlikely that superimposed concentrations from individual sources would substantially exceed those calculated for the point of maximum ground level concentration. Therefore, ground level concentrations from each of the sources listed in Table VI-17 were considered separately.

TABLE VI-17
PROJECTED 1 HR. MAXIMUM GROUND LEVEL CONCENTRATIONS OF AIR POLLUTANTS
LOS ANGELES COUNTY SANITATION DISTRICTS - JOINT WATER POLLUTION CONTROL PLANT
Reasonable Worst Case Emissions

	PROJECTED GROUND LEVEL CONCENTRATIONS (1-HR.) IN $\mu\text{g}/\text{m}^3$							
	LOW WIND CASE ($u_L = 1.77 \text{ m/sec}$)				HIGH WIND CASE ($u_H = 4.64 \text{ m/sec}$)			
	IC/BOILER	CCP	DFTP		IC/BOILER	CCP	DFTP	CRITICAL WIND CASE, u_C
1978 BASE								
NOx	143	48	52		284	85	54	453
SOx	11	7	36		16	12	30	19
TSP	6	2	7		10	4	8	15
CO	18	19	2		37	34	2	58
HC	53	5	1		110	9	1	180
PHASE II (CFTP = 238 TON/DAY)								
NOx	164	48	52		268	85	54	313
SOx	2	7	36		3	12	30	4
TSP	4	2	7		7	4	8	15
CO	22	19	2		36	34	2	41
HC	67	5	1		117	9	1	128
PHASE II (DFTP = 357 TON/DAY)								
NOx	164	48	54		286	85	60	313
SOx	2	7	38		3	12	42	4
TSP	4	2	7		7	4	8	15
CO	22	19	2		38	34	2	41
HC	67	5	8		117	9	9	128
PHASE III								
NOx	44	50	50		79	79	60	108
SOx	7	34	40		12	12	40	16
TSP	2	6	9		4	4	9	5
CO	18	2	3		32	32	3	43
HC	5	1	1		8	8	1	11

SOURCE: LA/DMA Project

NOTE: a. Reasonable worst case emission levels were assumed. Mobile emissions were not included in the analysis.
b. Low wind speed is the average of the lowest 4 mean hourly wind speeds based on 1956-1976 data collected at the Long Beach Airport.
High wind speed is the average of the highest 4 mean hourly wind speeds. Critical wind speed is that calculated to give the maximum ground level concentration.

Special plume transport and dispersion conditions known as looping, limited mixing, coning, fanning, and fumigation were evaluated using recommended EPA procedures (Ref. 3). These transport conditions can potentially result in high short-term concentrations, however, analysis indicates that concentrations significantly different than the maximum 1-hour concentrations shown in Table VI-17 should not result from these transport phenomena. In view of this finding, no further consideration was given to these special transport conditions.

Downwash is a condition in which aerodynamic turbulence induced by a building causes a pollutant emitted from an elevated source to be mixed rapidly toward the ground. Analysis indicates a possibility for downwash, although, it is believed that proper facility design can avoid such a condition.

The estimated maximum ground level concentrations assume a constant wind speed and an averaging time of about one hour. Increasing the averaging time would reduce the values shown in Table VI-17 because the time interval would encompass more variations in wind speed, direction, and stability class. EPA guidelines state that a factor of 0.4 (+0.2) should be used in adjusting 1-hour concentrations to a 24-hour averaging time (Ref. 4). On an annual average basis it would not be unreasonable to expect an order of magnitude reduction in average ground level concentration from the indicated 1-hour maximum.

Projected ground level concentration increments of particulates and carbon monoxide under the reasonable worst case should be considerably less than the most stringent ambient air quality standards for these pollutants. Pollutants of most concern are oxides of nitrogen (NO_x), sulfur dioxide (SO_2), and hydrocarbons (HC).

With the exception of SO_2 , highest ground level concentration increments will be associated with internal combustion (IC) engines. Under the critical wind speed condition, ground level concentration increments of NO_x and HC associated with IC engines could approach ambient air quality standards. Standards for NO_x could be exceeded if exhaust temperatures are substantially decreased below assumed levels. However, raising the stack height would mitigate against possible ground level exceedence. HC concentrations from IC engines are also of concern because of potential for photochemical oxidant formation.

Ground level concentration increments of NO_x and SO_2 associated with the combined cycle system (CCP) and thermal processing reactor (DFTP) should be substantially less than the most stringent ambient air quality standards. Ground level concentration increments of HC associated with the CCP and DFTP would also be well below the most stringent ambient air quality standard.

Ground level increments from IC engines would remain about the same as the 1978 Base level. Other sources (DFTP and CCP) would result in NO_x and HC ground level

concentration increments substantially lower than 1978 Base levels and essentially equivalent TSP and CO ground level increments. Increases largely attributable to the DFTP in ground level SO₂ increments of 20 to 25 ug/m³ are projected.

There is apparently little difference in resulting ground level concentration increments between the two module scenario (250 dtpd) and the three module scenario (375 dtpd). It has been assumed that additional stack flue area would be provided for the higher tonnage scenario. If, however, the same stack were used as with the lower tonnage scenario, a higher discharge velocity will result, with consequent higher plume rise, increased dispersion, and reduced ground level increments.

The air emission analysis included evaluation of the potential discharge of heavy metals during thermal processing and related health impacts. Details of the analysis are presented in Ref. 6. A major conclusion of the analysis was that negligible health effect would be expected based on the proposed design of the thermal processing system. Stack heights of 50 to 150 feet appeared to be acceptable for dispersion purposes. In order to limit the release of toxicant containing particulates into the environment, extremely efficient particulate control devices should be used, such as a fabric filter baghouse. Particular attention should be given to capture of submicron particles. It was recommended that total particulate loading in the exhaust flue gas be kept at 0.01 gr/ACF or lower, preferably at the state of the art design, and that adequate air monitoring sampling be done to assume reliable performance.

Transportation Requirements

Char/ash from thermal processing and dewatered digested sludge would be transported from the Joint Water Pollution Control Plant for disposal. Assuming that such materials are trucked to Puente Hills landfill, transportation requirements would be as follows:

<u>RESIDUALS</u>	<u>DAILY AMOUNT (CUBIC/YARDS)</u>	<u>ANNUAL ROUND TRIPS</u>	<u>ANNUAL VMT</u>	<u>TRUCK INTERVAL (MINUTES BETWEEN TRUCKS)</u>
Char/Ash	150	2010	121,000	36
Dewatered Sludge	650	7910	475,000	9

The foregoing estimates are based upon dry weather operations (120 dry tons per day of dewatered sludge at about 22 percent solids), including consideration of fixed carbon content of the char/ash, and assume 300 working days (8 hours per day) per year. Transport of composted sludge to the recycle center would not involve use of public thoroughfares.

If char/ash is not accepted for disposal at Puente Hills, such material would be transported either to Calabasas Class I Landfill or BKK Class I Landfill for disposal. Table VI-18 describes transportation requirements associated with hauling to both landfills and compares such requirements with hauling to Puente Hills Landfill.

The foregoing information is applicable only to use of public streets and thoroughfares and does not include transportation activities occurring entirely within project boundaries.

Public Facilities Requirements

Public facilities demands are presented in Table VI-19 in terms of solid waste to be managed and disposed of in landfills; liquid sidestreams produced during sludge processing which would be recycled to the wastewater treatment plant; cooling water requirements; and potable water supply demands.

The largest single residual requiring disposal in landfills would be dewatered sludge and char/ash from thermal processing. Lesser amounts would be produced by the flue gas desulfurization system and digester cleaning operations.

Sidestreams would result from mechanical dewatering and condensate from dehydration and thermal processing. Cooling water required for dehydration, thermal processing, and combined cycle power generation would be obtained through reclamation of secondary wastewaters. Filtration of secondary effluent may be required. While it is believed unlikely, if secondary effluent cannot be used, cooling water demands would need to be met from potable water sources.

Potable water would be required for digester heating and for condensate makeup water for dehydration and the steam turbine included in the thermal processing system for energy recovery.

Energy Production and Consumption

Energy production and consumption arising from the proposed program is shown in Table VI-20. Electrical energy would be produced from thermal processing and combustion of digester gas in the combined cycle power system. In addition to electrical consumption demands, projected consumption of diesel fuel for truck transport of residuals to landfill; makeup requirements for Isopar (a fractionated isoparaffinic hydrocarbon) lost during dehydration; and polymer consumption for conditioning of sludge prior to dewatering are also reported.

TABLE VI-18

CHAR/ASH TRUCKING COMPARISON FOR PHASE II
LOS ANGELES COUNTY SANITATION DISTRICTS

Year 2000 PS Plus WAS from 200 MGD Secondary Treatment

	JWPCP TO PUENTE HILLS			JWPCP TO BKK			JWPCP TO CALABASAS		
	2 MODULES	3 MODULES		2 MODULES	3 MODULES		2 MODULES	3 MODULES	
Tonnage, dtpd	80	137		88	137		88	137	
One-Way Distance (Miles)	30	30		38	38		43	43	
Annual Capital Cost (\$000)(1)	109	109		138	138		156	156	
O & M Costs (\$000/Yr)(2)	141	220		179	278		202	315	
Fuel, Labor, Maintenance	96	150		96	150		96	150	
Dump Charge	237	370		275	428		298	465	
Total	97	151		123	191		139	216	
Diesel Fuel (Gal/Day)(3)									
Emissions (Lb/Day)(4)									
TSP	1	2		2	3		2	3	
NOx	13	20		16	25		18	28	
SO ₂	2	3		3	4		3	4	
CO	17	26		21	23		24	37	
HC	3	4		3	5		4	6	
Cubic Yards/Day	150	231		150	231		150	231	
Round Trips/Yr	2,010	3,125		2,010	3,125		2,010	3,125	
VMT/Yr	121,000	188,000		153,000	238,000		173,000	269,000	
Truck Interval (Min)/Trip(5)	36	23		36	23		36	23	

SOURCE: LA/OMA Project, Projections based on November 1978 computer runs and unit process design criteria, CH2M-Hill Engineers.

- (1) Directly proportional from Puente Hills case by mileage hauled. Note that capital cost is the same regardless of whether 2 or 3 C-G modules are operated since trucks must be available for maximum load.
- (2) Fuel, labor and maintenance directly proportioned from Puente Hills using mileage and tonnage hauled. Dump charge at \$3/ton.
- (3) Directly proportioned from Puente Hills case using mileage and tonnage hauled.
- (4) Based on diesel fuel use, 135,000 BTU/Gal., and standard emission factors.
- (5) Minutes between trucks.

TABLE VI-19

PUBLIC FACILITIES DEMANDS FOR PHASE II
LOS ANGELES COUNTY SANITATION DISTRICTS

Year 2000 PS Plus WAS from 200 MGD Secondary Treatment

PROCESS	SOLID WASTE (WTPD) ^(a)	SIDESTREAMS (MGD) ^(b)	COOLING WATER (MGD) ^(b)	POTABLE WATER (MGD) ^(c)
WAS Thickening	0	1.4	0	0
Anaerobic Digestion	0	0	0	0.13
Mechanical Dewatering	330-670(d)	3.2	0	0
Dehydration	0	0.4	4.6	(h)
Thermal Processing	90-165(e)	0.5	5.5	0.03(h)
Combined Cycle	0	0	7.7	0
Windrow Composting	0	0	0	0
Compost to Landfill	0	0	0	0
Dewatered Sludge to Landfill	330-670(d)	0	0	0
Char/Ash to Landfill	90-165(e)	0	0	0
Digester Residue to Landfill	350 WTPYR(f)	0	0	0
Baghouse Residue to Landfill	Included in char/ash	0	0	0
Flue Gas Desulfurization Scrubber Sludge	30-45(g)	0	0	0

(a) Wet tons per day (WTPD) except as otherwise indicated.

(b) Values rounded up to nearest 0.1 million gallons per day (MGD).

(c) Values rounded up to nearest 0.005 MGD.

(d) Values rounded up to nearest 10 WTPD. Range corresponds to 75 to 150 dtpd of dewatered sludge at 22.5 percent solids.

(e) Values rounded up to nearest 5 WTPD. Higher value corresponds to operation of three modules and reduced carbon burnout.

(f) Values rounded up to nearest 50 wet tons per year (WTPYR).

(g) Values rounded up to nearest 5 WTPD. Higher value corresponds to operation of three modules.

(h) Includes condensate makeup water for dehydration and steam turbine system associated with thermal processing.

TABLE VI-20
ENERGY PRODUCTION AND CONSUMPTION FOR PHASE II
LOS ANGELES COUNTY SANITATION DISTRICTS
Year 2000 PS Plus WAS from 200 MGD Secondary Treatment

PROCESS	DIGESTER GAS PRO- DUCTION (MM BTU/DAY)(1)	ELECTRICITY PRODUCED (KWH/DAY)	ELEC- TRICITY CONSUMED (KWH/DAY)	NET ELECTRICAL PRODUCTION (KWH/DAY)	DIESEL FUEL CONSUMED (GALLONS/ DAY)(3)	ISOPAR CONSUMED (GALLONS/ DAY)(3)	POLYMER CONSUMED (LB/DAY)(3)
WAS	---	---	13,500	-13,500	---	---	---
Thickening	---	---	---	---	---	---	---
Anaerobic Digestion	456	---	48,900	-48,900	---	---	5,500
Mechanical Dewatering	---	---	20,900	-20,900	---	---	---
Dehydration	---	---	33,500	-33,500	---	700	---
Thermal Processing	---	95,500	18,300	77,200	---	---	---
Char/Ash Trucking(2)	---	---	---	---	100	---	---
Wet Cake Trucking(2)	---	---	---	---	380	---	---
Advanced Wind- row Composting	---	---	300	-300	560	---	---
Combined Cycle Power Generation	---	386,400	---	386,400	---	---	---
Sidestream Processing	---	---	1,100	-1,100	---	---	---
TOTAL	456	481,900	136,500	345,400	1,040	700	5,900

(1) Excludes digester gas used for electrical power production in the combined cycle system. Energy requirements for digester heating are assumed to be supplied by waste heat sources.

(2) To Puente Hills Landfill.

(3) Electrical equivalent of diesel fuel, Isopar oil, and polymer organics is about 13 KWH/gal, 13 KWH/gal, and 1.73 KWH/lb, respectively.

Net electrical production is projected to be about 345,400 KWH/day (14.4 MW). The electrical equivalent of digester gas used in internal combustion engine drives is about 45,600 KWH/day. The electrical equivalent of diesel fuel, Isopar, and polymer consumed in the process is about 32,800 KWH/day. Net energy production from the Phase II facilities is, therefore, about 358,200 KWH/day (14.9 MW) electrical equivalents.

PHASE III OPTIONS

Phase III options have been defined for each of the LA/OMA operating agencies from information available at the time of program development. It is recognized that new information may become available during Phase II which could alter the range of options available during Phase III. The Phase III options, however, provide identification of currently indicated long range alternatives. For the Los Angeles County Sanitation Districts, reasonable Phase III options appear to be continuation of Phase II facilities; complete reliance on energy recovery via dehydration/thermal processing; and complete reliance on mechanical composting. Landfilling of dewatered sludge is not considered to be a viable long range alternative. However, an evaluation of landfill disposal will provide information that will be valuable in finalizing the sizing of Phase II facilities.

Projected sludge loadings for Phase III options are given in Table VI-21 and accommodate all sludge from primary treatment of 330 MGD and secondary treatment of all primary effluent. With respect to the level of secondary treatment that may ultimately be required, the Phase III options would accommodate sludges produced by "full secondary" treatment.

The Phase III options represent an upper limit for sizing of Phase II facilities and provide flexibility for expansion of composting operations by shifting from the advanced windrow system to an enclosed mechanical system. Analysis of the Phase III options provides a description of the maximum potential environmental impacts that might be realized (1) if full secondary treatment or other factors necessitate expansion of Phase II facilities beyond the loadings described earlier or (2) if, for reasons not known at this time, the sludge processing system must be shifted more heavily to composting or energy recovery.

Quantitative information for the Phase III options is provided in the following sections. Information is also provided for landfill disposal of dewatered sludge to enable consideration of concerns regarding ability to landfill large amounts of dewatered sludge. Quantitative information for Phase III options has been developed using the same unit factors as were used in the development of quantitative information for the Phase II facilities. Information for enclosed mechanical composting was developed by updating information used in the assessment of alternative sludge management projects (Decentralized Dewatering and Composting) to the same basis as the Phase II quantitative information. It has been assumed that each option would process the entire Phase III sludge load for purposes of

TABLE VI-21

**MAXIMUM POTENTIAL SLUDGE LOADING ON PHASE III FACILITIES
LOS ANGELES COUNTY SANITATION DISTRICTS**

Year 2000 PS Plus WAS from Full Secondary Treatment

PROCESS	FEED SLUDGE RATE (DRY TONS PER DAY) (a)			REMARKS
	PRIMARY	WAS	BLEND	
<u>LOADINGS COMMON TO ALL TRAINS</u>				
Raw Sludge to Anaerobic Digestion	590	215		Primary includes effect of sidestream recycle to headworks.
Digested Sludge to Dewatering	390	165	555	
Output from Dewatering			530	Assumes 95 percent capture.
<u>DEHYDRATION AND ENERGY RECOVERY</u>				
Dehydration			530	
Thermal Processing			530	
Char/Ash to Landfill			215	Assumes total fixed carbon burnout. Would be about 270 dtpd with reduced burnout efficiency.
<u>COMPOSTING AND RECYCLING</u>				
Enclosed Mechanical Composting			530	
Recycle Center/Landfill			370	

(a) All values rounded up to the nearest 5 dry tons per day (dtpd).

analysis. Obviously such a situation would not occur. The information given therefore represents a maximum that would result from total reliance on any single option.

Economic Characteristics: Projected costs were examined under Phase III conditions of year 2000 primary sludge recovery and full secondary treatment. Results for the case of dehydration and energy recovery (Train C of Figure VI-4) are shown in Table VI-22 and for the case of composting and recycling (Train B of Figure IV-4) in Table VI-23. In the latter case, it was assumed that mechanical composting would replace the advanced windrow composting used in Phase II.

For the case of full energy recovery, capital costs of about \$165,000,000 are projected with a net annual cost of \$20,000,000/yr. For the case of full mechanical composting, capital costs are roughly estimated at \$123,000,000 with net annual costs of about \$16,000,000/yr. These cost estimates should be viewed with extreme caution. In the case of mechanical composting, for example, a demonstration project is recommended during Phase II to develop better design criteria for the process. The cost estimates shown in Table VI-23 are based on information presently available, but most certainly will change as new design criteria are developed. Therefore, one should not necessarily conclude that mechanical composting is more cost effective than full energy recovery by thermal processing, due to the uncertain nature of the cost estimates at this time.

Air Pollutant Emission: Table VI-24 shows projected mass emission of air pollutants for the Phase III options. For purposes of analysis, the values shown in the table assume that all digester gas will be used in the combined cycle system.

Compared to 1978 base emissions, large emission reductions for both HC and NO_x are expected for the case of full thermal processing. CO emissions would remain about the same. TSP emissions under the reasonable design case would increase by about 175 lbs/day, which is about equal to the electrical offset for TSP under Phase III conditions. An increase in SO_x emissions of about 745 lb/day is projected under the reasonable design case. However, this increase is less than the electrical offset under Phase III.

Mass emission rates for the case of full composting are also shown in Table VI-24. Compared to 1978 base emissions, large emission reductions for HC and NO_x are expected. CO and TSP remain about the same. SO_x emissions are projected to either decrease or increase depending on whether the design or worst case is considered. The electrical power offset is substantially greater than the increase projected under the worst case analysis.

TABLE VI-22
QUANTITATIVE CHARACTERISTICS OF PHASE III FACILITIES
DEHYDRATION AND ENERGY RECOVERY
L.A. COUNTY SANITATION DISTRICTS-JOINT WATER POLLUTION CONTROL PLANT
Full Secondary Treatment - Year 2000 Sludge Loads

JOINT WATER POLLUTION CONTROL PLANT - LACSD	DAF THICKENING	ANAEROBIC DIGESTION	LIQUID STORAGE	MECHANICAL DEWATERING	WET CAKE STORAGE	DEHYDRA- TION	THERMAL PROCESSING	CHAR/ASH TRUCK	COMBINED CYCLE PLANT	TOTAL
587 dry tons per day - PS	223	827	555	555	530	1046*	530	215	-	799
212 dry tons per day - WAS										
DESIGN LOAD (dry tons/day)(a) (* tons of H ₂ O/day)	223	827	555	555	530	1046*	530	215	-	799
OPERATING LOAD (dry tons/day)(b) (* tons of H ₂ O/day)										
SIZING										
LAND AREA REQUIRED (acres)	0.7	5.2	0.8	2.0	0.6	0.9	1.5	5	0.3	12
EMPLOYEES (No. per 24 hrs)	9	18		15		8	5		9	69
POLYMER USED (lbs/day)	700			6200						6900
ISOPAR L USED (gal/day)						1580				1580
O ₂ FOR RECYCLE (tons/day)				2.4		1.5				3.9
ENERGY										
ELECTRICITY USED (KWH/DAY)	22300	56200		17900		61000	4000			197400
ELECTRICITY PRODUCED (KWH/DAY)							226100		461200	607300
DIESEL FUEL USED (gal/day)								190		190
O ₂ FOR RECYCLE (KWH/DAY)				750		500			1250	1250

(a) Design load refers to the tonnage of solids or water used for estimation of capital cost.
(b) Operating load refers to the tonnage of solids or water used for estimation of O & M costs.

TABLE VI-22 (Continued)

QUANTITATIVE CHARACTERISTICS OF PHASE III FACILITIES
DEHYDRATION AND ENERGY RECOVERY
L.A. COUNTY SANITATION DISTRICTS-JOINT WATER POLLUTION CONTROL PLANT

Full Secondary Treatment - Year 2000 Sludge Loads

JOINT WATER POLLUTION CONTROL PLANT - LACSD	DAF THICKENING	ANAEROBIC DIGESTION	LIQUID STORAGE	MECHANICAL DEWATERING	WET CAKE STORAGE	DEHYDRA- TION	THERMAL PROCESSING	CHAR/ASH TRUCK	COMBINED CYCLE PLANT	TOTAL
CAPITAL COST (\$000)										
LAND	0	0	0	0	0	0	0	0	0	0
PROCESS	18916	23453	4048	13699	8108	44656	40406	565	11075	164926
TOTAL CAPITAL	18916	23453	4048	13699	8108	44656	40406	565	11075	164926
TOTAL ANNUAL CAPITAL	1768	2192	378	1280	758	4174	3777	137	1035	15399
OPERATIONS AND MAINTENANCE COST (\$000), TOTAL ANNUAL	1314	1994		5895		2814	1512	585	865	14979
CREDITS (\$000)										
SALE OF COMPOST										
VALUE OF FUEL										
VALUE OF ELECTRICITY										
TOTAL ANNUAL CREDITS										
NET ANNUAL O & M COST (\$000/YR)	1314	1994		5895		2814	-1789	585	-5869	4944
TOTAL NET ANNUAL CAPITAL AND O & M COST (\$000/YR)	3082	4186	378	7175	758	6988	1988	722	-4834	20343
TOTAL ANNUAL COST/TON OF DRY FEED (\$/TON)	37.9	13.9	2.0	35.4	3.9	36.1	10.3	9.2	-	69.8

TABLE VI-23
QUANTITATIVE CHARACTERISTICS OF PHASE III FACILITIES
DEHYDRATION AND ENERGY RECOVERY
L.A. COUNTY SANITATION DISTRICTS-JOINT WATER POLLUTION CONTROL PLANT
Full Secondary Treatment - Year 2000 Sludge Loads

JOINT WATER POLLUTION CONTROL PLANT - LACSD	DAF THICKENING	ANAEROBIC DIGESTION	LIQUID STORAGE	MECHANICAL DEWATERING	WET CAKE STORAGE	MECH. COMPOSTING	SLUDGE RECYCLE CENTER	COMBINED CYCLE PLANT	TOTAL
567 dry tons per day - PS									
212 dry tons per day - WAS									
DESIGN LOAD (dry tons/day) (a) (* tons of H ₂ O/day)	223	827	526	555	530	530	370	-	799
OPERATING LOAD (dry tons/day) (b) (* tons of H ₂ O/day)	223	827	526	555	530	530	370	-	799
SIZING									
LAND AREA REQUIRED (acres)	0.7	5.2	0.8	2.0	0.6	48	-	0.3	57.6
EMPLOYEES (No. per 24 hrs)	9	18		15		15		9	66
POLYMER USED (lbs/day)	700			6200					6900
ISOPAR L USED (gal/day)									
O ₂ FOR RECYCLE (tons/day)				2.4					2.4
ENERGY									
ELECTRICITY USED (KWH/DAY)	22300	56200		17900		7100			103500
ELECTRICITY PRODUCED (KWH/DAY)								461200	461200
DIESEL FUEL USED (gal/day)						310			310
O ₂ FOR RECYCLE (KWH/DAY)				750					750

(a) Design load refers to the tonnage of solids or water used for estimation of capital costs.
(b) Operating load refers to the tonnage of solids or water used for estimation of O & M costs.

TABLE VI-23 (Continued)

QUANTITATIVE CHARACTERISTICS OF PHASE III FACILITIES
DEHYDRATION AND ENERGY RECOVERY

L.A. COUNTY SANITATION DISTRICTS-JOINT WATER POLLUTION CONTROL PLANT

Full Secondary Treatment - Year 2000 Sludge Loads

JOINT WATER POLLUTION CONTROL PLANT - LACSD	DAF THICKENING	ANAEROBIC DIGESTION	LIQUID STORAGE	MECHANICAL DEWATERING	WET CAKE STORAGE	MECH. COMPOSTING	SLUDGE RECYCLE CENTER	COMBINED CYCLE PLANT	TOTAL
587 dry tons per day - PS									
212 dry tons per day - MAS									
CAPITAL COST (\$000)									
LAND	0	0	0	0	0	0	0	0	0
PROCESS	18916	23453	4048	13699	8108	48655	0	11075	127,954
TOTAL CAPITAL	18916	23453	4048	13699	8108	48655		11075	127,954
TOTAL ANNUAL CAPITAL	1768	2192	378	1280	758	4548		1035	11959
OPERATIONS AND MAINTENANCE COST (\$000), TOTAL ANNUAL	1314	1994		5895		1125		865	11193
CREDITS (\$000)									
SALE OF COMPOST							386		386
VALUE OF FUEL								6734	6734
VALUE OF ELECTRICITY							386	6734	7120
TOTAL ANNUAL CREDITS									
NET ANNUAL O & M COST (\$000/YR)	1314	1994		5895		1125	-386	-5869	4073
TOTAL NET ANNUAL CAPITAL AND O & M COST (\$000/YR)	3082	4186	378	7175	758	5673	-386	-5869	16032
TOTAL ANNUAL COST/TON OF DRY FEED (\$/TON)	37.9	13.9	2.0	35.4	3.9	29.3			55.0

TABLE VI-24
ESTIMATED AIR POLLUTANT EMISSIONS FOR PHASE III OPTIONS
LOS ANGELES COUNTY SANITATION DISTRICTS

Year 2000 PS Plus WAS from Full Secondary Treatment
(All values in pounds per day.)

CASE PROCESSES	ENERGY RECOVERY					MECHANICAL COMPOSTING/RECYCLING					LANDFILL DISPOSAL OF DEMATERED SLUDGE				
	HC AS	CO CH ₄	SO ₂ AS	NO _x AS	NO ₂ NO _x	HC AS	CO CH ₄	SO ₂ AS	NO _x AS	NO ₂ NO _x	HC AS	CO CH ₄	SO ₂ AS	NO _x AS	NO ₂ NO _x
REASONABLE PLANNING CASE															
Thermal Processing	39	68	781	449	230	166	651	48	1626	76	166	651	48	1626	76
Combined Cycle	166	651	48	1626	76	166	651	48	1626	76	166	651	48	1626	76
Trucks	5	33	4	25	3	9	54	6	41	5	39	248	30	188	23
TOTAL (1.2)	210	755	835	2100	310	175	705	55	1670	85	205	900	80	1815	100
REASONABLE WORST CASE															
Thermal Processing	49	85	1562	2243	287	208	813	302	2033	95	208	813	302	2033	95
Combined Cycle	208	813	302	2033	95	208	813	302	2033	95	208	813	302	2033	95
Trucks	6	41	5	31	3	11	67	8	51	6	49	311	37	234	26
TOTAL (1.2)	265	940	1870	4310	385	220	880	310	2085	105	260	1125	340	2270	125
Emission Offsets From Electrical Production (1.3)	90	100	1325	1125	200	65	75	970	820	145	65	75	990	835	150

- (1) Values rounded up to nearest 5 pounds per day.
 (2) All digester gas assumed to be used in the combined cycle power system.
 (3) Compensating emissions resulting from production of electrical energy by sludge processing which would otherwise be supplied by an electrical utility.
 (4) Not a Phase III option. Provided for informational purposes only.

Ground level concentrations of pollutants expected under Phase III conditions were shown previously in Table VI-17. Referring to Table VI-17, ground level concentrations with full composting can be approximated by considering only the CCP column, since that is the only stationary source in the system. Both the CCP and DFTP columns should be considered in the case of full energy recovery. Incremental increases are less than ambient ground level standards in either case. Comparing Phase II with Phase III, projected ground level concentrations of air pollutants attributable to the CCP and DFTP remain about the same. Higher mass emissions under Phase III are compensated by the greater discharge of flue gas. Comparing Phase III with the 1978 base condition, significant reductions in NO_x and HC ground level concentrations are predicted. A slight increase in ground level SO_x concentration is predicted in the case of full energy recovery.

Transportation Requirements: Under the Phase III options, only the energy recovery option would require transport of residuals from the Joint Water Pollution Control Plant. Marketing studies (Ref. 7) indicate that assuming regulatory requirements permit, market demand exists for all composted sludge that would be produced by the mechanical composting option. 8

Under the energy recovery option, approximately 360 cubic yard per day of char/ash would be truck transported. Assuming such material is transported to Puente Hills Landfill, approximately 3,230 round trips would be made annually resulting in a total of about 194,000 vehicle miles travelled (VMT) per year. Assuming 300 working days per year and 8 hours per working day, a truck interval of 20 minutes between trucks is calculated.

If all the digested sludge projected to be projected to be produced in year 2000 under full secondary treatment were to be landfilled (not a Phase III option), approximately 2,805 cubic yards of material would need to be transported. Assuming that such material is transported to Puente Hills Landfill for disposal, approximately 34,110 round trips would be made annually resulting in about 2,047,000 VMT per year. Assuming 300 working days per year and 8 hours per working day, the truck interval is calculated to be 20 minutes between trucks.

Public Facilities Requirements: Public facilities demands for the Phase III options and landfill disposal of dewatered sludge are presented in Table VI-25. Information on solid waste to be managed, resultant liquid sidestreams produced during sludge processing, cooling water requirements, and potable water demands is presented.

Energy Production and Consumption: Electrical energy production and demand associated with the Phase III options is provided in Table VI-26. Also shown are the amounts of diesel fuel, isopar, and polymer consumed. It is assumed for purposes of evaluation that all digester gas would be used in the combined cycle power generation system.

TABLE VI-25
PUBLIC FACILITIES DEMANDS FOR PHASE III OPTIONS
LOS ANGELES COUNTY SANITATION DISTRICTS
YEAR 2000 PS PLUS WAS FROM FULL SECONDARY TREATMENT

OPTION: PROCESS	ENERGY RECOVERY				MECHANICAL COMPOSTING/RECYCLE				LANDFILL DISPOSAL OF DEMATERED SLUDGE			
	SOLID WASTE (MTPD)	SIDE-STREAMS (MGD)	COOLING WATER (MGD)	POTABLE WATER (MGD)	SOLID WASTE (MTPD)	SIDE-STREAMS (MGD)	COOLING WATER (MGD)	POTABLE WATER (MGD)	SOLID WASTE (MTPD)	SIDE-STREAMS (MGD)	COOLING WATER (MGD)	POTABLE WATER (MGD)
MAS Thickening	0	2.3	0	0	0	2.3	0	0	0	2.3	0	0
Anaerobic Digestion	0	0	0	0.17	0	0	0	0.17	0	0	0	0.17
Mechanical Dewatering	0	3.5	0	0	0	3.5	0	0	0	3.5	0	0
Dehydration	0	0.5	5.5	(1)	0	0	0	0	0	0	0	0
Thermal Processing	265(d)	0.8	9.4	0.045	0	0	0	0	0	0	0	0
Mechanical Composting	0	0	0	0	0	0	0	0	0	0	0	0
Combined Cycle	0	0	9.2	0	0	0	9.2	0	0	0	9.2	0
Wet Cake to Landfill	0(d)	0	0	0	0	0	0	0	2385(g)	0	0	0
Char/Ash to Landfill	265(d)	0	0	0	0	0	0	0	0	0	0	0
Compost to Landfill	0	0	0	0	0	0	0	0	0	0	0	0
Digester Residue to Landfill	400 MTPYR(e)	0	0	0	400 MTPYR(e)	0	0	0	0	0	0	0
Baghouse Residue to Landfill	Included in Char/Ash	0	0	0	0	0	0	0	0	0	0	0
Flue Gas Desulfurization Scrubber Sludge	70(f)	0	0	0	0	0	0	0	0	0	0	0

(a) Net tons per day (MTPD) except as otherwise indicated.

(b) Values rounded up to the nearest 0.1 million gallons per day (MGD).

(c) Values rounded to nearest 0.005 MGD.

(d) Assumes some fixed carbon in char/ash.

(e) Rounded up to nearest 50 wet tons per year (MTPYR).

(f) Rounded to nearest 5 MTPD. Special handling may be required which may, in turn, necessitate disposal at another landfill.

(g) At 22.5 percent solids. Corresponds to 540 dry tons per day.

(h) Not a Phase III option. Included for informational purposes.

(i) Includes condensate makeup water for dehydration and steam turbine system associated with thermal processing.

TABLE VI-26
ENERGY PRODUCTION AND CONSUMPTION FOR PHASE III OPTIONS
LOS ANGELES COUNTY SANITATION DISTRICTS
YEAR 2000 PS PLUS WAS FROM FULL SECONDARY TREATMENT

OPTION	ENERGY RECOVERY				MECHANICAL COMPOSTING/RECYCLE				LANDFILL DISPOSAL OF Dewatered Sludge (e)			
	ELECTRICAL ENERGY (a) PRODUCED (G) REQUIRED NET (KILOWATT HOURS PER DAY)	DIESEL (b) FUEL USED (GPD)	SOLAR (c) FUEL USED (GPD)	POLYMER (c) USED (LB/DAY)	ELECTRICAL ENERGY (a) PRODUCED (G) REQUIRED NET (KILOWATT HOURS PER DAY)	DIESEL (b) FUEL USED (GPD)	POLYMER (c) USED (LB/DAY)	ELECTRICAL ENERGY (a) PRODUCED (G) REQUIRED NET (KILOWATT HOURS PER DAY)	DIESEL (b) FUEL USED (GPD)	POLYMER (c) USED (LB/DAY)	ELECTRICAL ENERGY (a) PRODUCED (G) REQUIRED NET (KILOWATT HOURS PER DAY)	DIESEL (b) FUEL USED (GPD)
WAS Thickening	0	22,300	-22,300	0	0	22,300	-22,300	0	22,300	-22,300	0	700
Aerobic Digestion	0	56,700	-56,700	0	0	56,700	-56,700	0	56,700	-56,700	0	0
Mechanical Dewatering	0	17,900	-17,900	0	0	17,900	-17,900	0	17,900	-17,900	0	6,200
Beltdewatering	0	61,000	-61,000	0	0	0	0	0	0	0	0	0
Thermal Processing	226,100	40,000	186,000	0	0	0	0	0	0	0	0	0
Mechanical Composting	0	0	0	0	0	7,100	-7,100	310	0	0	0	0
Combined Cycle	441,200	0	441,200	0	0	441,200	0	441,200	0	441,200	0	0
Truck Transport	0	0	0	190	0	0	0	0	0	0	0	1,440
Sludgestream Processing	0	1,000	-1,000	0	0	1,000	-1,000	0	1,000	-1,000	0	0
TOTALS	647,300	196,400	450,900	190	441,200	104,500	356,700	310	441,200	97,400	363,800	1,440

(a) All values rounded to nearest 100 kwh/day.
(b) Values rounded to nearest 10 gallons per day (gpd).
(c) Values rounded to nearest 100 pounds per day (lb/day).
(d) Values rounded to nearest 100 pounds per day (lb/day).
(e) Values all digester gas is used in combined cycle power generation system.
(f) Not a Phase III option. Included for informational purposes.

PHASE II FACILITIES

Phase II facilities for the Orange County Sanitation Districts Joint Works will, as a minimum, be sized to accommodate all sludge from primary treatment of 280 MGD of wastewater and the waste activated sludge from secondary treatment of 150 MGD of primary effluent. Sludge loadings for the Phase II facilities projected to be produced by the year 2000 are given in Table VI-27.

The foregoing treatment levels have been specified in the Districts' application for waiver of secondary treatment requirements. Should additional secondary treatment be required, Phase II facilities would need to be expanded to accommodate a larger volume of waste activated sludge. A decision regarding the application for waiver of secondary treatment requirements has not yet been made. Should secondary treatment of all wastewaters be required, Phase II facilities requirements would be identical to the sludge loadings described for the Phase III options.

UNIT PROCESSES

A process flow diagram for the recommended Phase II facilities is shown in Figure VI-7. All waste activated sludge (WAS) would be thickened and anaerobically digested, either separately or in combination with primary sludge (PS). Flexibility will be provided to allow operation in either mode. Digester gas will be used in existing internal combustion (IC) engines and boiler facilities.

At the present time, centrifuge dewatering facilities exist at Plants No. 1 (Fountain Valley) and 2 (Huntington Beach). New belt press dewatering facilities are under design for Plant No. 2 and are scheduled to be operational in the early 1980's. As part of the Phase II facilities, it is planned to transport digested PS and WAS from Plant No. 1 via pipeline to Plant No. 2 for further processing. At Plant No. 2 all digested PS and WAS will be mechanically dewatered. The existing dewatering facility at Plant No. 1 will eventually be abandoned in favor of joint processing facilities at Plant No. 2. Expansion of the belt press and wet cake storage facilities currently under design for Plant No. 2 will then be undertaken.

Temporary storage of wet cake will be provided following mechanical dewatering. From this point, dewatered cake is truck hauled for further processing at an offsite facility. At present, offsite facilities are located at Coyote Canyon landfill. New facilities will be located in Round Canyon area.

TABLE VI-27

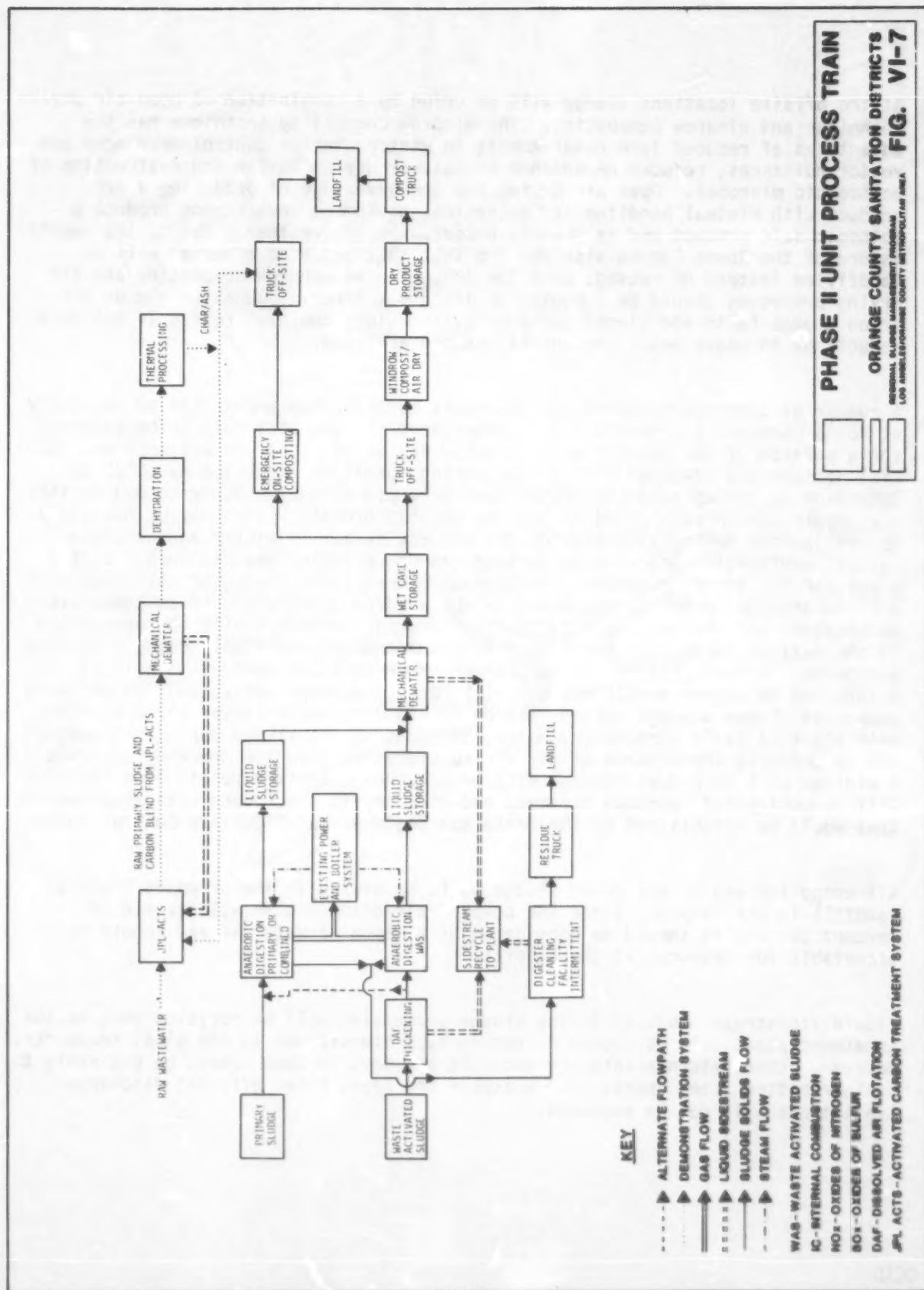
**SLUDGE LOADING ON PHASE II FACILITIES
ORANGE COUNTY SANITATION DISTRICTS**

Year 2000 PS Plus WAS From 150 MGD Secondary Treatment At Joint Works

<u>PROCESS</u>	<u>FEED SLUDGE RATE (DRY TONS PER DAY)^a</u>			<u>REMARKS</u>
	<u>PRIMARY</u>	<u>WAS</u>	<u>BLEND</u>	
Anaerobic Digestion	275	100		Includes effect of sidestream recycle to headworks.
Total Digested Sludge	175	75	250	
Mechanical Dewatering of digested PS & WAS			250	Probable cake solids of 25 percent.
Wet Cake Storage			240	Assumes 95 percent caputre in dewatering.
Truck Offsite			240	Assumes 95 percent caputre in dewatering, and 3-day storage (288 dry ton)
Windrow Compost(b)			240	
Landfill(c)			165-240	Lower value assumes 50 percent VS content and 50 percent VS loss during composting. Higher value assumes air drying is used in place of composting, assume no VS loss.

SOURCE: LA/OMA Project - CH2M Hill Engineers, Projections based on August 1979 computer runs and unit process design criteria.

- (a) All sludge tonnages rounded up to the nearest 5 dry tons per day (dtpd).
- (b) Sludge loadings may be increased by about 65 to 80 dtpd if digested sludge from other Orange County agencies is processed in the facility.
- (c) Tonnages would be about 220 to 320 dtpd if other Orange County sludges are included.



At the offsite locations sludge will be dried by a combination of open air drying technique and windrow composting. The windrow composting technique has the advantages of reduced land requirements in winter, better control over odor and vector nuisances, reduced dependence on natural drying forces and destruction of pathogenic microbes. Open air drying has the advantage of producing a dry product with minimal handling and mechanical equipment, but cannot produce a pathogen safe product and is severely hampered by wet weather. Due to the remote nature of the Round Canyon site and the fact that produced material will be landfilled instead of reused, both the conventional windrow composting and air drying processes should be adequate during dry weather. Composted and/or air dried sludge (with additional pathogen destruction) could be reused if suitable reductions in heavy metal concentrations are achieved.

A number of site improvements and materials handling equipment will be necessary at Round Canyon. A concrete pad or other hard surface will need to be provided for a portion of the compost area to allow equipment access in wet weather. OCSO will monitor the advanced windrow composting operation conducted by LACSD to determine if forced aeration system should be placed in the concrete pad so that air supply can be controlled during the compost process. This may be necessary to realize the drying potential of the windrow system in winter months since natural ventilation and windrow turning cannot be relied upon to supply sufficient air for drying purposes. Mechanical metering and mixing of all components will be provided prior to placement in the windrow to ensure uniform temperature development and the maximum efficiency of drying. Windrows will be constructed to the maximum dimensions consistent with commercially available compost turning equipment. A stockpile of dry compost or other suitable amendments will be maintained to assure sufficient material for wet weather operation. An enclosed dewatered sludge storage system will be provided at Round Canyon and the treatment plant(s) avoid unnecessary water additions to the sludge during wet weather and to decouple the windrow or air drying operation from the trucking schedule. A minimum of 1 to 2 days storage will be provided. Surface runoff from the site will be controlled, perhaps treated, and disposed in accordance with requirements that would be established by the Santa Ana Regional Water Quality Control Board.

All composted and/or air dried sludge would be hauled to the proposed Class II landfill in Bee Canyon. Since the compost/air dried sludge will exceed 50 percent solids, it should be considered as a Group II material and should be acceptable for disposal at the landfill.

Liquid sidestream produced during sludge processing will be recycled back to the treatment plant. It is common to return such sidestreams to the plant headworks. However, other return points are possible and may, in some cases, be desirable to achieve better plant operation. Whatever the case, final effluent discharge limitations will not be executed.

Storage

Intermediate storage facilities are provided at four points: (1) liquid sludge storage in digesters, (2) dewatered sludge storage following mechanical dewatering, (3) dewatered sludge storage at the Round Canyon facility and (4) an emergency storage/composting site at Plant No. 1. Temporary enclosed storage for about 1 day for liquid sludge and 3 days of wet cake storage (split between treatment plant and Round Canyon) locations is envisioned. Additionally, 6 to 9 months storage of air dried sludge would also need to be provided at the Round Canyon site. Sizing of storage facilities will be finalized during detailed facilities design.

Standby Capacity

The intermediate storage facilities shown in Figure VI-7 represent additional backup in the event of temporary process shutdown. As such, the storage facilities are an essential element of the total process train and add to system reliability.

An emergency 10-acre composting site will be provided at Plant No. 1 to serve as back-up system in the event that dewatered cake cannot be hauled offsite for processing. Standby equipment and a stockpile of composted material would be maintained at the site to allow for quick start up. It is anticipated that these facilities would be needed on an intermittent basis and only for limited time periods.

Wet Weather Operation

The Round Canyon facility will encounter its most serious operating difficulties during wet weather and will be designed to handle the worst case situation. Analysis of open air drying (Ref. 6) indicates that land requirements can increase by five to ten fold during winter months. Composting can effect significant moisture removal from the heat of biological decomposition. However, the extent of drying is usually thermodynamically limited by the cake solids produced from dewatering. Sufficient energy may not be available to assure complete drying unless cake solids exceed about 30 percent. As a result, conventional windrow composting may also experience difficulty in wet weather.

There are a number of potential ways to resolve the wet weather problem. Three will be discussed here, two of which appear particularly well suited to the Round Canyon situation.

First, wet cake could be air dried during dry months, stockpiled and then blended with wet cake during winter months to achieve a 50 percent solids mixture. The problem with this approach is the enormous quantity of air dried sludge required to achieve the desired blend. OCSD is expected to produce about 235 dtpd. If this is at 20 percent solids, about 945 dtpd of air dried sludge at 80 percent solids would be required to produce a blend with 50 percent solids. It is doubtful that sufficient air dried sludge could be produced in 8 dry months to satisfy the demands imposed during 4 wet months. Further, about 2,360 wet tons per day (wtpd) would require landfill disposal in the wet season, which is probably the worst time in terms of landfill operation. Therefore, this approach is not considered attractive for the Round Canyon operation.

Second, composting could be conducted on a year-round basis. Dry product produced during summer months could be stockpiled for use as recycle during wet months. This would relieve the windrow operation from having to produce a dry product during wet weather, but still should provide a material sufficiently dry for landfill disposal. Compost produced in wet weather could be stockpiled to avoid high landfill loads in wet weather. Even though the compost would still be moist, odor production in the stockpile would be minimized due to the stabilized nature of the organics. The major difficulty with this approach will be maintenance of elevated compost temperatures in winter months.

Third, part or all of the sludge could be air dried during summer months and then stockpiled. Air drying would continue until the sludge reaches 80 to 90 percent solids. This is sufficient to reduce rates of bacterial activity to very low levels. This will serve two purposes: (1) the potential for odor production in the stockpile will be reduced; and (2) organics will be conserved for use during wet weather when the thermodynamic balance is most stressed. During wet months, air dried sludge from the stockpile would be added with wet cake to achieve a suitable starting mixture (i.e. initial solids content above 40 percent). If no organic decomposition has occurred in the stockpile, this should be equivalent thermodynamically to producing sludge with 40 percent solids from dewatering. In other words, composting of dewatered sludge amended with air dried sludge should have thermodynamic advantage and significant drying should be possible even with moderate water additions from rainfall. Air dried sludge which has been stockpiled would not be reused until it has been composted to control pathogens or until tests show that dessication and detention time have provided sufficient pathogen destruction.

Demonstration Facility

Both OCSD and EPA have expressed interest in continued development of the JPL-ACTS process, which has been pilot tested in a 1 MGD facility at Plant No. 2. This process uses sludge organics to produce an activated carbon which is then used in the wastewater treatment process. Therefore, development of the JPL-ACTS process may have implications for the long-range management of sludges.

OCSD is pursuing funding to partially redesign and reactivate the 1 MGD JPL-ACTS pilot facility. Purpose of the study would be to gather additional field data and demonstrate performance characteristics of the improved design. The project could possibly be completed as early as June 1981. Pending conclusions of the study, a decision would be made to proceed with design and construction of a large scale demonstration facility. If the results of the 1 MGD pilot study are encouraging, the demonstration facility would be sized to process about 20 dtpd of raw primary sludge. Final size, however, will depend on a number of factors to be evaluated by the JPL-ACTS pilot facility.

In the JPL-ACTS process, a blend of primary sludge and recycled carbon would be dewatered, dried, and thermally processed for energy and char/carbon production. It should be recognized that use of primary solids in the ACTS process will result in an increase in the WAS fraction of remaining digested sludges. This will affect dewatering properties to some extent, but the impact is expected to be minor with a 20 dtpd demonstration facility.

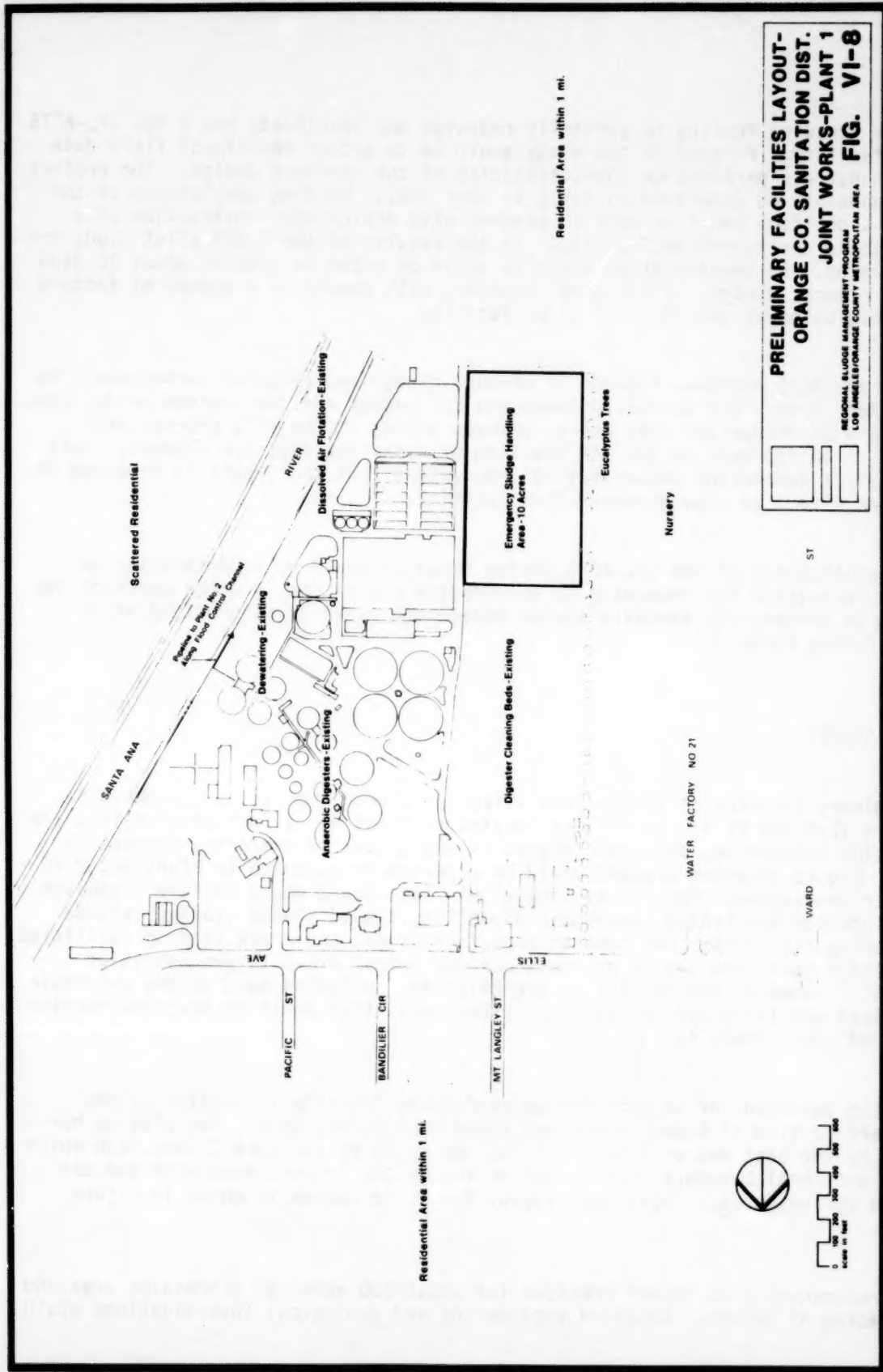
Since utilization of the JPL-ACTS during Phase II would be demonstration in nature, provision has been made to accommodate all sludge in other parts of the system to assure that adequate sludge management capacity is provided at all times during Phase II.

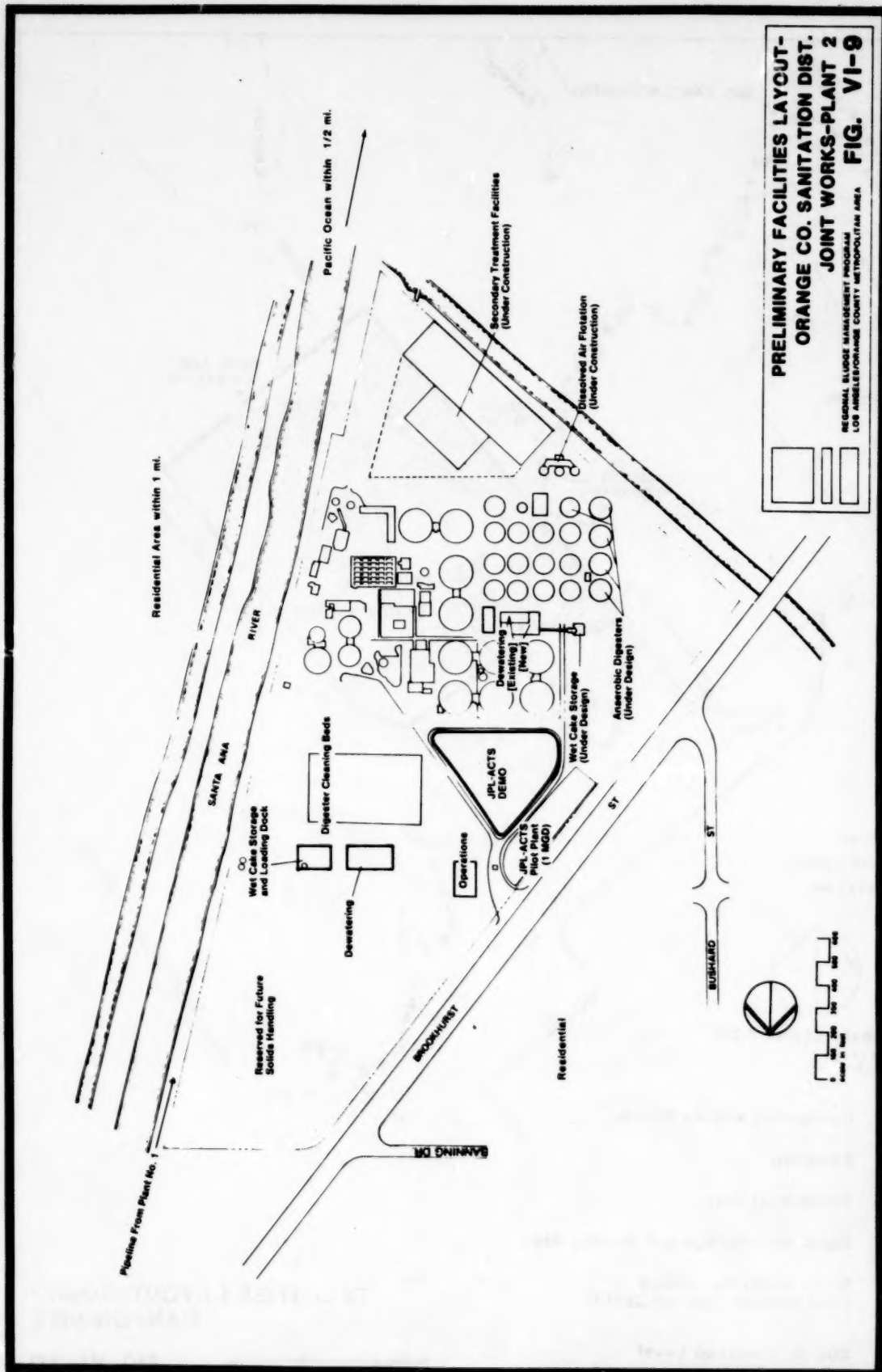
SITE LAYOUTS

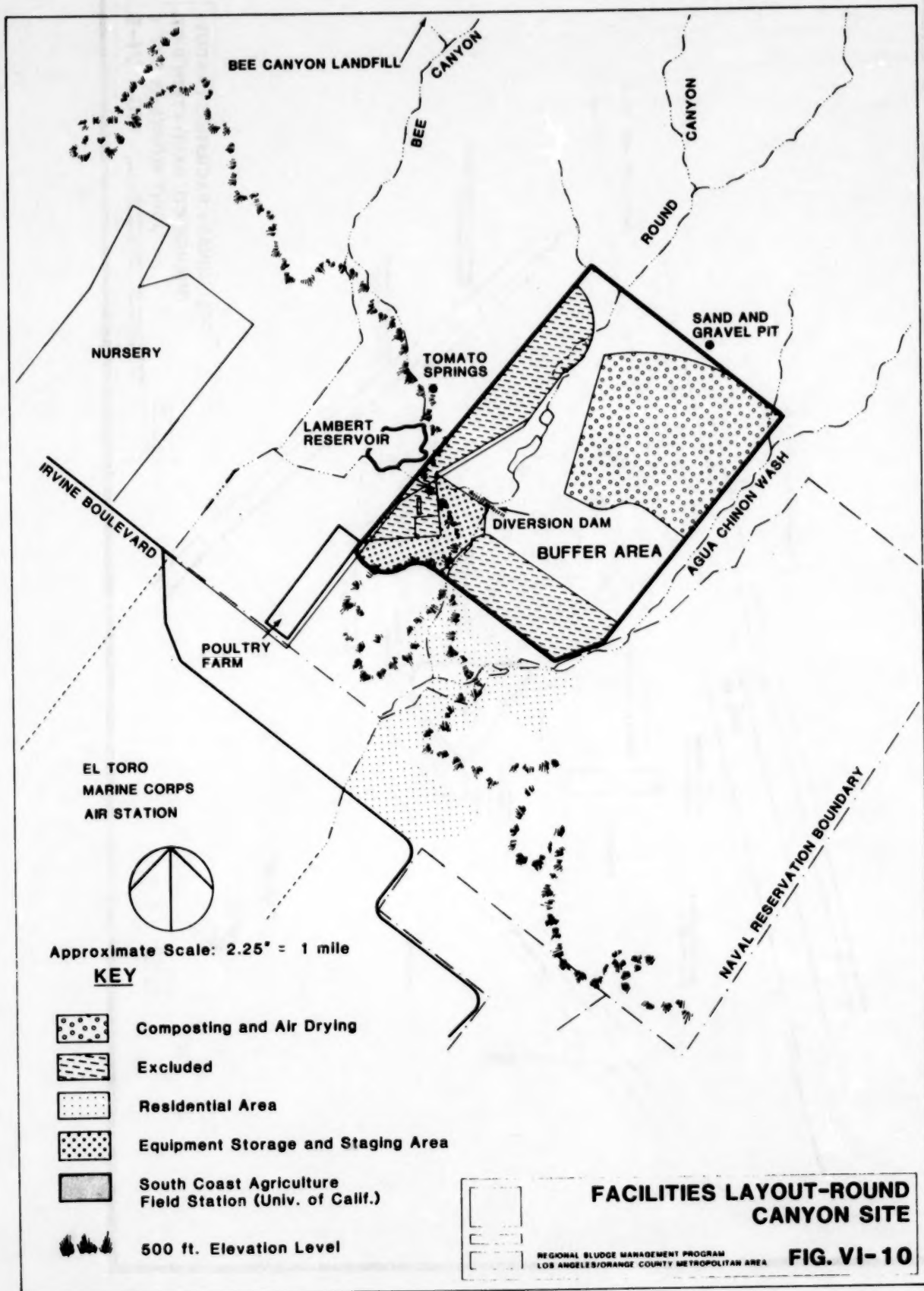
Preliminary location of onsite facilities for sludge processing are shown in Figures VI-8 and VI-9. Facilities located at Plant No. 1 include dissolved air flotation thickening, anaerobic digestion and a 10-acre emergency composting site. Liquid digested sludges would be pipeline transported to Plant No. 2 for further processing. Facilities located at Plant No. 2 would include dissolved air flotation thickening, anaerobic digestion, liquid sludge storage, sludge dewatering facilities, wet cake storage facilities, and truck loading facilities for sludge cake, and the 20 dry tons per day (dtpd) JPL-ACTS demonstration facility. Some of the facilities are existing, including most of the anaerobic digesters and flotation thickeners. Other facilities would be new construction required under Phase II.

The site selected for offsite sludge processing facility is located in the southern portion of Round Canyon and above Agua Chino Wash. The site is bordered to the east and west by hills, to the south by the Agua Chino Wash which forms a natural boundary, and to the north, by the Lambert reservoir and the Tomato Springs area. Facilities layout for Round Canyon is shown in Figure VI-10.

The preliminary site layout provides for about 100 acres of processing area and 200+ acres of buffer. Detailed engineering and geological investigations would







be conducted during facilities design to develop a detailed site plan. As part of the project, and prior to onsite engineering and/or geological surveys, and construction of facilities, an archaeological investigation will be conducted by a qualified archaeologist (listed by the Society of Professional Archaeologists) to determine the significance of all archaeological artifacts. Arrangements will be made for implementation of a cultural resources mitigation program if such is deemed necessary by the Cultural Affairs offices of the State Water Resources Control Board or other such competent authority.

Land would be graded as necessary for the processing facility. Facilities will be built to control surface runoff and to prevent it from reaching stream beds off site. Runoff collected within the site and which has been exposed to sludge material would be stored in retention basins. Runoff collected in the basin would be managed by one of the following methods: (1) Physical-chemical treatment for removal of suspended solids and pathogen destruction before discharging into the stream beds, (2) gradual release of stored runoff into the nearest trunk sewer, or (3) storage and onsite evaporative use for irrigation and dust control purposes.

The necessary facilities will be placed to insure a safe wet weather operation and compliance with water quality requirements to be established by the Santa Ana Regional water Quality Control Board.

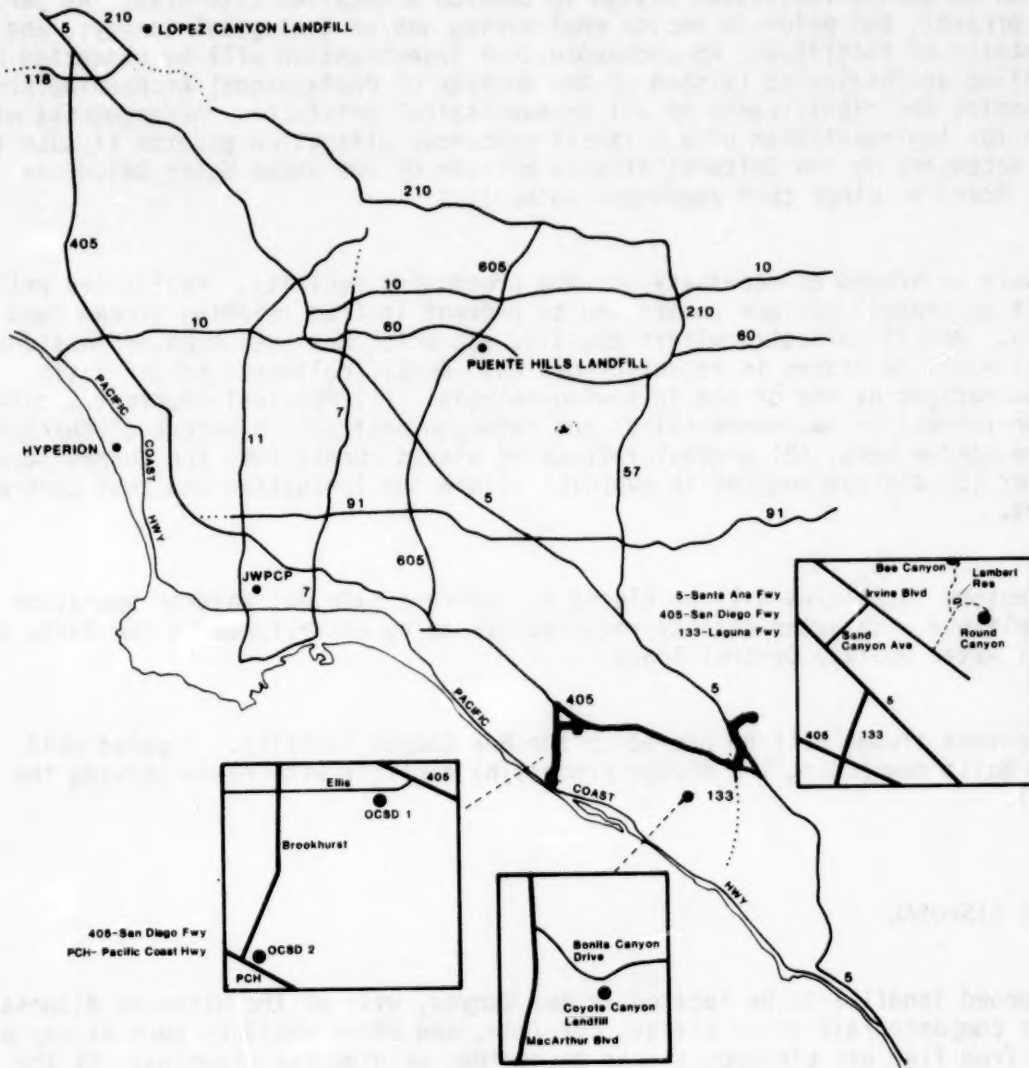
The processed sludge will be hauled to the Bee Canyon landfill. A paved road will be built connecting the sludge processing facility with roads serving the landfill.

ULTIMATE DISPOSAL

The proposed landfill to be located in Bee Canyon, will be the ultimate disposal site for composted/air dried sludge, char/ash, and other residues such as may be derived from flue gas cleanup, sludge screening, or digester cleaning. At the present time, the Santa Ana Regional Water Quality Board requires sludge solids to be at least 50 percent dry before being disposed of at Orange County landfills, which are all Class II sites (Ref. 8). Residuals from the project should meet this criterion.

TRANSPORTATION ROUTES

In the Phase II Sludge Management Program for OCSD, dewatered digested sludge cake would be hauled by truck from OCSD Plant No. 2 to the Round Canyon processing site. There are a number of possible truck routes between the treatment plant and the Round Canyon site. The route shown in Figure VI-11 was selected



Approx. scale 1 inch=10.1 miles

NOTE: Scale not applicable to insets



NOTE: Numbers correspond to freeways

	TRANSPORTATION ROUTES
	ORANGE COUNTY SANITATION DISTRICTS
	REGIONAL SLUDGE MANAGEMENT PROGRAM
	LOS ANGELES/ORANGE COUNTY METROPOLITAN AREA

FIG. VI-11

for purposes of analysis since significant truck traffic is already present and major contact with residential areas is avoided.

Assuming the selected route, trucks would leave the solids processing area at Plant No. 2 and take Brookhurst Avenue North to the San Diego Freeway South. The Laguna Freeway and Santa Ana Freeway would be used to reach the Sand Canyon off-ramp. Sand Canyon Road and Irvine Boulevard would be used to reach the general area of Round Canyon. A new all weather road will be required to reach the proposed processing site. Trucks hauling residuals to the Bee Canyon landfill will use Irvine Boulevard and planned entrance road to Bee Canyon landfill.

QUANTITATIVE INFORMATION

Quantitative information has been developed by LA/OMA Project for the proposed Phase II facilities. This information, together with the foregoing qualitative description, was used in the assessment of the proposed sludge management program.

Economic Characteristics

Design and operating loads, sizing, and energy use and production, and capital and O & M costs for each unit process within the Phase II treatment train are shown in Table VI-28. The following assumptions apply to the data shown in Table VI-28.

- Mechanical dewatering produces a cake of 23 percent solids with 14 lb/ton polymer and 95 percent capture.
- Capital costs for all unit processes shown in Figure VI-7 are included with the exception of capital costs for DAF thickening which has already been committed for construction by OCSD. Existing digester capacity was assumed to be $5.225 \times 10^6 \text{ ft}^3$ which includes new circular digesters committed for construction at Plant No. 2 in 1979. Capital cost for digestion reflects only additional digester requirements.
- Liquid digested sludge storage for 1 day and wet cake storage for 3 days are provided for the entire sludge flow. O & M costs for liquid and wet cake storage are included in the O & M costs for anaerobic digestion and mechanical dewatering, respectively.
- Cost factors shown in Table VI-1 are applicable.
- A new structure is included in the capital cost for mechanical dewatering.

TABLE VI-28

QUANTITATIVE CHARACTERISTICS OF PHASE II FACILITIES
SIZING, ENERGY, AND COSTS

OCSD - Plants No. 1 and No. 2 and Round Canyon

JOINT WORKS - OCSD	DAF THICKENING	ANAEROBIC DIGESTION	LIQUID STORAGE	PIPELINE TO PLANT NO. 2	MECHANICAL DEWATERING	WET CAKE STORAGE	WET CAKE TRUCK	COMPOST AIR DRY AT ROUND CANYON	COMPOST TRUCK	TOTAL
260 dry tons per day - PS										
96 dry tons per day - WAS										
DESIGN LOAD (dry tons/day) (* tons of H ₂ O/day)	101	368	249	116	249	236	236	316(a)	316	356
OPERATING LOAD (dry tons/day) (* tons of H ₂ O/day)	101	368	249	116	249	236	236	316(a)	316	356
SIZING										
LAND AREA REQUIRED (acres)	0.4	0.7	0.3	-	1.0	0.4	-	290(b)	-	293
EMPLOYEES (No. per 24 hrs)	6	9	-	-	9	-	17	18	4	63
POLYMER USED (lbs/day)	303				3478					3781
ISOPAR L USED (gal/day)					1.2					1.2
O ₂ FOR RECYCLE (tons/day)										
ENERGY										
ELECTRICITY USED (KWH/DAY)	10105	25157		1164	8144			698		45268
ELECTRICITY PRODUCED (KWH/DAY)										
FUEL OIL USED (gal/day)					366					
FUEL PRODUCED (tons/day)										
DIESEL FUEL USED (gal/day)							542	1504	148	2194
O ₂ FOR RECYCLE (KWH/DAY)					366					366

(a) Included 80 dtpd sludge input from other Orange County Agencies.

(b) Includes buffer land.

TABLE VI-28 (Continued)

QUANTITATIVE CHARACTERISTICS OF PHASE II FACILITIES
SIZING, ENERGY, AND COSTS

OCSD - Plants No. 1 and No. 2 and Round Canyon

JOINT WORKS - OCSD	DAF THICKENING	ANAEROBIC DIGESTION	LIQUID STORAGE	PIPELINE TO PLANT NO. 2	MECHANICAL DENATURING	WET CAKE STORAGE	WET CAKE TRUCK	COMPOST AIR DRY AT ROUND CANYON	COMPOST TRUCK	TOTAL
260 dry tons per day - PS										
96 dry tons per day - WAS										
CAPITAL COST (\$000)										
LAND	0	0	0	0	0	0	0	6960	0	6960
STRUCTURAL	-	C.	C.	C.	1402	C.	C.	1402	C.	1402
PROCESS	-	2727	1932	1512	4850	4557	1912	13405	341	31236
TOTAL CAPITAL	-	2727	1932	1512	6252	4557	1912	20365	341	39598
TOTAL ANNUAL CAPITAL	-	255	181	141	584	426	465	1993	83	4128
OPERATIONS AND MAINTENANCE COST (\$000)	302	452			452		855	905	206	3172
LABOR							129	357	35	521
DIESEL FUEL										
FUEL OIL										
ELECTRICITY	147	367		17	119			10		661
POLYMERS	221				2539					2760
ISOPAR L										
MAINTENANCE	17	94		10	175		194	15	8	513
RECYCLE OXYGEN					13					13
DUMP CHARGE									692	692
TOTAL ANNUAL O & M	688	913		27	3298		1178	1287	941	8332
CREDITS (\$000)										
SALE OF COMPOST										
VALUE OF FUEL		-2709								-2709
VALUE OF ELECTRICITY										
TOTAL ANNUAL CREDITS		-2709								-2709
NET ANNUAL O & M COST (\$000/YR)	688	-1796		27	3298		1178	1287	941	5623
TOTAL NET ANNUAL CAPITAL AND O & M COST (\$000/YR)	688	-1541	181	168	3882	426	1643	3280	1024	9751
TOTAL ANNUAL COST/TON OF DRY FEED (\$/TON)	18.7	-11.5	2.0	4.0	42.7	4.9	19.1	28.4	8.9	75.0(d)

(c) Structural cost included in process cost.
(d) Based on OCSD sludge contribution only.

- 80 dtpd of digested sludge from other Orange County Agencies is assumed to be delivered to the Round Canyon site. Capital and O & M costs to process and dispose of this sludge at Round Canyon are included in the analysis. Costs for transportation to the Round Canyon site are not included.
- Capital costs for composting/air drying at the Round Canyon site include land purchase of 290 acres at \$20,000/acre, site grading and preparation paving and forced aeration system for 35 acres, mobile equipment, wet cake storage facilities, and preliminary facilities.
- All produced digester gas is assumed to be used in existing IC engines. No capital on O & M costs are assigned to the IC engines, but use of the digester gas is valued at \$3/mm Btu. Waste heat recovered for the IC engines is projected to be sufficient for digester heating purposes.

Based on these assumptions a total capital cost of \$39,600,000 is estimated, which is equivalent to \$4,128,000/yr. Total annual O & M is estimated at \$8,332,000/yr with credits for the value of fuel produced at \$2,709,000/yr. The net cost, defined as annual capital plus O & M less credits, is about \$9,751,000/yr. The latter is equivalent to about \$75.0/dry ton of raw sludge processed through the system (based on OCSD sludge contribution only).

If only OCSD sludges are processed at the Round Canyon site, capital costs at Round Canyon would be reduced to about \$18,400,000, equivalent to an annual cost of \$1,814,000/yr. O & M would be about \$922,000/yr giving a total annual cost of \$2,736,000/yr, compared to the \$3,280,000/yr shown in Table VI-28. If costs for trucking and landfill disposal of the compost product are considered, the total cost increment for handling the 80 dtpd of other Orange County sludges is estimated at about \$827,000/yr, equivalent to about \$28.3/dry ton.

Air Pollutant Emissions

Air pollutant mass emission estimates are shown in Table VI-29 for the Phase II facilities that would be located at the Orange County Sanitation Districts Joint Works.

Air pollution emission estimates have been developed by LA/OMA Project from application of unit emission factors shown in Chapter VII. Factors for total suspended particulates (TSP), nitrous oxide (NO_x), sulfur oxides (SO_x), hydrocarbons (HC), and carbon monoxide (CO) have been developed through literature reviews, field and laboratory testing, and consultations with manufacturers and air quality regulatory and planning agencies.

Air pollutant mass emissions have been developed for two cases. Use of these two cases in the environmental impact analysis assures that a range of potential impacts is identified and effects of uncertainty associated with development of the emissions estimates would be minimized.

The "reasonable planning case" has been defined based upon use of sophisticated air emission control equipment and operation of such equipment at the design removal efficiencies. Specific assumptions underlying the "reasonable planning case" are: (1) 80 percent removal of hydrogen sulfide from digester gas prior to combustion, (2) selective catalytic reduction to achieve 90 percent removal of NO_x in flue gas from the JPL-ACTS demonstration facility, (3) fabric filters for particulate removal to achieve a particulate concentration of 0.01 grains per actual cubic foot at 400°F in the flue gas from JPL-ACTS demonstration facility, and (5) other emission factors as shown in Table VII-5.

The "reasonable worst case" has been defined based upon the assumption that air emission cleanup equipment would function at less than design efficiencies and in some instances, inclusion of lower levels of control. Complete failure of a process or its associated air emission control system was not included since the modular design of most systems would include standby capacity for sludge processing and air emission controls. Specific assumptions underlying the "reasonable worst case" are (1) no removal of hydrogen sulfide from digester gas, (2) flue gas desulfurization achieves 300 ppm (v) in flue gas from the JPL-ACTS Demonstration Facility, (3) no NO_x removal from flue gas from JPL-ACTS facility, and (4) other emission factors shown in Table VII-5 (excluding those for reciprocating engines and electrical utility power generation) are increased by 25 percent, including the hydrogen sulfide content of digester gas.

The emissions shown in Table VI-29 account for all emissions which would occur as a direct result of the proposed sludge management program. Emissions from combustion of digester gas are not a direct result of the proposed project, but are charged to existing internal combustion engines or assumed expansion of such systems and are provided in Table VI-29 for informational purposes. Since OCSD does not plan to generate electrical power onsite at the Joint Works, emissions produced by an electrical utility to supply electrical power consumption for sludge processing are also shown. Emissions estimates for a 20 dtpd JPL-ACTS demonstration system were developed assuming the emission factors shown in Chapter VII for thermal processing.

The foregoing estimates are not meant to imply that lower emission levels are not attainable. There is good evidence that lower particulate and sulfur dioxide emissions from thermal processing would be achievable with application of innovative techniques and control systems (Ref. 2). It is also recognized that selective catalytic NO_x reduction systems have not been reliably demonstrated in applications involving solid fuels. On the other hand, there appear to be good prospects that non-selective catalytic NO_x reduction systems can achieve greater than 50 percent removal efficiencies in the type of application envisioned by the proposed sludge management project. Questions of this nature should be resolvable by incorporation of any needed mitigation measures (if the environmental

TABLE VI-29

ESTIMATED AIR POLLUTANT MASS EMISSION RATES FOR PHASE II FACILITIES
ORANGE COUNTY SANITATION DISTRICTS

Year 2000 PS Plus WAS from Full Secondary Treatment

(All values in pounds per day.)

CASE UNIT PROCESS	HC AS CH ₄	CO AS CO	SO AS SO ₂	NO AS NO ₂	TSP
1978 BASE EMISSIONS	1685	525	670	4120	200
Reasonable Planning Case					
Truck to Round Canyon	15	94	11	71	8
Compost/Air Drying ⁽¹⁾	41	260	31	196	22
Truck to Landfill	4	25	2	18	2
JPL-ACTS Demonstration	2	3	36	21	11
Total ⁽²⁾	65	385	80	310	45
Reasonable Worst Case					
Truck to Round Canyon	19	118	14	89	10
Compost/Air Drying ⁽¹⁾	51	325	39	245	28
Truck to Landfill	5	31	3	23	3
JPL-ACTS Demonstration	3	4	215	207	14
Total ⁽²⁾	80	480	275	565	55
IC ENGINES ⁽²⁾	3465	1065	1380	8415	220
Emission From Energy Production By Utility ^(3,4)	10	10	125	105	20

(1) Emissions are from windrow turning devices.

(2) Values rounded up to nearest 5 pounds per day (lb/day).

(3) Emissions from assumed continued use of digester gas in internal combustion engines. Not a direct result of proposed project. Included for informational purposes.

(4) Emissions produced by electrical utility to produce electricity to supply sludge processing demand.

analysis based upon the range of air pollutant mass emissions given in Table VI-29 discloses significant adverse impacts) and during design of facilities.

Referring to Table VI-29. Direct project emissions include all unit processes shown in Figure VI-7 with the exception of digester gas combustion. Of the direct emissions, only the JPL/ACTS demonstration project is a stationary source, the remainder being mobile emissions. Digester gas use in IC engines is the major source of air emissions for all pollutants. Direct project emissions represent a relatively small fraction of the IC engine emissions. Indirect emissions resulting from purchase of electrical power are less than direct project emissions, except from SO_x under the reasonable design case.

Incremental increases in ground level concentrations of oxides of nitrogen (NO_x), oxides of sulfur (SO_x), particulated (TSP), carbon monoxide (CO), and hydrocarbons (HC) have been estimated for the proposed Phase II Facilities and the Phase III Options. Ground level concentrations were estimated using the standard Gaussian dispersion model and calculation procedures described by Turner and Budney (Ref. 3, 4). Stack heights and exhaust gas temperature and velocities consistent with good engineering practice were assumed. A number of wind speeds were examined in the analysis. Assumptions used in the development of ground level concentrations are:

- Gaussian dispersion model using Pasquill-Gifford dispersion coefficients. Maximum centerline concentrations used in the analysis.
- Atmospheric stability class "D" as recommended by staff of the South Coast Air Quality Management District. (Ref. 5)
- Assumed stack heights of (1) thermal processing, 100 feet; (2) combined cycle plant, 50 feet; (3) boilers, 30 feet; and (4) internal combustion engines 40 feet.
- Plume rise calculation using Brigg's Formula.
- Velocity of stack discharges -- 50 feet per second (15.2 meters per sec.).
- Flue gas exhaust temperature of (1) thermal processing, 175°F; (2) combined cycle plant, 250°F; (3) boilers, 350°F; and (4) internal combustion engines, 525°F.
- Critical wind velocity (the wind velocity resulting in maximum centerline ground level concentrations) was examined in each case.

- A "high" wind case based upon the average of the highest four mean hourly wind speeds for all directions and a "low" wind case based upon the average of the lowest four mean hourly wind speeds.
- Wind speed data taken during 1956-76 for the Newport Monitoring Station.

Only stationary sources were included in the analysis. Although emissions from mobile sources are a significant regional problem, analysis indicates that the levels associated with the proposed facilities will not be substantial at the local level; since projected mass emission rates are small and will be widely dispersed. Construction emissions were not included because substantial long-term emissions are not anticipated.

Estimated incremental increases in 1-hour ground level increases for the reasonable worst case emission levels are shown in Table VI-30. The concentrations shown are maximum centerline ground level concentrations separately calculated for each discharge point. Values are shown for internal combustion engines (IC), combined cycle powerplant (CCP), and thermal processing reactor (DFTP). Assumptions and mass emission rates of pollutants for the reasonable worst case and both scenarios are provided in this Chapter under the discussion of air quality.

Ground level increments estimated for the individual point sources are not directly additive, since the indicated concentrations do not usually occur at the same location. Distance from the source to the maximum centerline concentration varies significantly depending upon the characteristics of the discharge. In addition, ground level concentrations decrease rapidly with increasing lateral distance from the plume centerline. Thus it is unlikely that superimposed concentrations from individual sources would substantially exceed those calculated for the point of maximum ground level concentration. Therefore, ground level concentrations from each of the sources listed in Table VI-30 were considered separately.

Special plume transport and dispersion conditions known as looping, limited mixing, coning, fanning, and fumigation were evaluated using recommended EPA procedures (Ref. 3). These transport conditions can potentially result in high short-term concentrations; however, analysis indicates concentrations significantly different from the maximum 1-hour concentrations shown in Table VI-30 should not result from these transport phenomena. In view of this finding, no further consideration was given to these special transport conditions.

Downwash is a condition in which aerodynamic turbulence induced by a building causes a pollutant emitted from an elevated source to be mixed rapidly toward the ground. Analysis indicates a possibility for downwash; however, it is believed that proper facility design can avoid such a condition.

TABLE VI-30
PROJECTED 1 HR. MAXIMUM GROUND LEVEL CONCENTRATIONS OF AIR POLLUTANTS
ORANGE COUNTY SANITATION DISTRICT PLANTS NO. 1 AND NO. 2

Reasonable Worst Case Emissions

PROJECTED GROUND LEVEL CONCENTRATIONS (1-HR.) IN ug/M ³													
		LOW WIND CASE ($u_L=1.56$ m/sec)				HIGH WIND CASE ($u_H=3.46$ m/sec)				CRITICAL WIND CASE, u_C			
		PLANT #1		PLANT #2		PLANT #1		PLANT #2		PLANT #1		PLANT #2	
		IC	DFTP	IC	DFTP	IC	DFTP	IC	DFTP	IC	DFTP	IC	DFTP
1978 BASE													
NOx		230	188	310	55	338	307	493	35	355	422	598	678
SOx		31	25	51	57	45	40	81	36	47	55	97	112
TSP		6	5	9	4	9	8	14	2	9	11	14	19
CO		28	24	39	1	41	39	62	1	43	53	76	86
HC		95	77	128	1	139	126	202	1	146	173	245	278
PHASE II													
NOx		362	310	55		528	493	513	90	598	719	93	
SOx		59	51	57		86	81	84	63	97	118	65	
TSP		9	9	4		13	14	13	12	14	18	12	
CO		46	39	1		67	62	65	3	76	91	4	
HC		148	128	1		216	202	212	2	245	296	2	
PHASE III													
NOx		362	319	76		528	513	513	90	598	719	93	
SOx		59	52	53		86	84	84	63	97	118	65	
TSP		9	8	10		13	13	13	12	14	18	12	
CO		46	41	3		67	65	65	3	76	91	4	
HC		148	131	2		216	212	212	2	245	296	2	

SOURCE: LA/OMA Project

- NOTE:
- a. Reasonable worst case emission levels were assumed. Mobile emissions were not included in the analysis.
 - b. Low wind speed is the average of the lowest 4 mean hourly wind speeds based on 1956-1976 data collected at the Newport Beach monitoring station. High wind speed is the average of the highest 4 mean hourly wind speeds. Critical wind speed is that calculated to give the maximum ground level concentration.
 - c. DFTP refers to the proposed JPL/ACTS Demonstration.

The estimated maximum ground level, concentrations assume a constant wind speed and an averaging time of about 1 hour. Increasing the averaging time would reduce the values shown in Table VI-30 because the time interval would encompass more variations in wind speed, direction, and stability class. EPA guidelines state that a factor of 0.4 (+0.2) should be used in adjusting 1-hour concentrations to a 24-hour averaging time (Ref. 4). On an annual average basis it would not be unreasonable to expect an order of magnitude reduction in average ground level concentration from the indicated 1-hour maximum.

Projected ground level concentration increments of particulates and carbon monoxide under the reasonable worst case should be considerably less than the most stringent ambient air quality standards for these pollutants. Pollutants of most concern are oxides of nitrogen (NO_x), sulfur dioxide (SO_2), and hydrocarbons (HC).

The JPL-ACTS Demonstration (DFTP) is projected to contribute minor ground level concentrations of NO_x , CO, and HC compared to the 1978 Base condition and compared to concentrations resulting from internal combustion (IC) engines used in Phase II. Essentially equivalent increments of TSP and CO are projected for the various sources.

Ground level concentration increments of NO_x , and possibly HC, attributable to the IC engines would be expected to exceed the most stringent ambient air quality standard and are higher than such concentrations associated with DFTP. HC concentrations are also of concern due to the potential for photochemical oxidant formation.

Ground level concentrations of NO_x , SO_2 , and HC are projected to be larger than 1978 Base conditions due to additional use of IC engines. NO_x increments are projected to increase by about 60 percent and HC by about 50 to 70 percent. Increases in ground level SO_2 from 25 to 60 $\mu\text{g}/\text{m}^3$ are estimated.

The air emission analysis included evaluation of the potential discharge of heavy metals during thermal processing and related health impacts. Details of the analysis are presented in Ref. 6. A major conclusion of the analysis was that negligible health effect would be expected based on the proposed design of the thermal processing system. Stack heights of 50 to 150 feet appeared to be acceptable for dispersion purposes. In order to limit the release of toxicant containing particulates into the environment, extremely efficient particulate control devices should be used, such as a fabric filter baghouse. Particular attention should be given to capture of submicron particles. It was recommended that total particulate loading in the exhaust flue gas be kept at 0.01 gr/ACF or lower, preferably at the state of the art design, and that adequate air monitoring and sampling be done to assure reliable performance.

Transportation Requirements

Under the proposed sludge management program, approximately 1,210 cubic yards per day of dewatered sludge would be trucked from the Joint Works to the Round Canyon Processing Site. Approximately 14,370 round trips would be made each year resulting in a total of 648,000 vehicle miles travelled (VMT) per year. Assuming 300 working days at eight hours per working day, a truck interval of five minutes between trucks is calculated.

Composted/air dried sludge would be trucked from Round Canyon to the proposed Bee Canyon landfill (using public thoroughfares) until such time as sludge quality is suitable for reuse. About 900 cubic yards per day would require approximately 10,950 round trips per year resulting in a total of 21,900 vehicle miles travelled (VMT) per year. Assuming 300 working days at eight hours per working day, a truck interval of 6.5 minutes is calculated.

The foregoing information is applicable only to use of public streets and thoroughfares and does not include transportation activities occurring entirely within project boundaries.

Public Facilities Requirements

Public facilities demands are presented in Table VI-31 in terms of solid waste to be managed and disposed of in landfills; liquid sidestreams produced during sludge processing which would be recycled to the wastewater treatment plant; cooling water requirements; and potable water supply demands.

The largest single residual requiring disposal in landfills would be dried sludge (at greater than 50 percent solids) from the Round Canyon Processing site. This demand would continue until sludge quality is consistent with recycling needs.

Sidestreams would result from mechanical dewatering. Since belt presses are in part to be used for mechanical dewatering, washwater is required for cleaning. Such demand would be met by reclamation of secondary effluent.

Potable water would be required for digester heating.

Energy Production and Consumption

Energy production and consumption arising from the proposed program during Phase II is shown in Table VI-32. Electrical energy would not be produced by

TABLE VI-31

PUBLIC FACILITIES DEMANDS FOR PHASE II
ORANGE COUNTY SANITATION DISTRICTS

Year 2000 PS Plus WAS from Full Secondary Treatment

PROCESS	SOLID WASTE (WTPD) (a)	SIDESTREAMS (MGD) (b)	COOLING WATER (MGD) (b)	POTABLE WATER (MGD) (c)
WAS Thickening	0	1.0	0	0
Anaerobic Digestion	0	0	0	0.075
Mechanical Dewatering	0	3.2	1.6	0
Compost/ Air Drying	630	(d)	0	0
Dried Sludge to Landfill	630(e)			
Digester Residue to Landfill	200 wtpyr(f)			

(a) Values rounded to nearest 10 wet tons per day (wtpd) except as otherwise noted.

(b) Values rounded to nearest 0.1 million gallons per day (MGD).

(c) Values rounded to nearest 0.005 MGD.

(d) Runoff from Round Canyon site must be collected, treated, and disposed. See project description of options.

(e) Rounded up to nearest 50 wet tons per year (wtpyr).

TABLE VI-32

ENERGY PRODUCTION AND CONSUMPTION FOR PHASE II
ORANGE COUNTY SANITATION DISTRICTS

Year 2000 PS Plus WAS From 150 MGD Secondary Treatment

PROCESS	GAS PRODUCTION(1) (mmBTU/day)	ELECTRICITY PRODUCED (KWH/DAY)	ELECTRICITY CONSUMED (KWH/DAY)	NET ELECTRICAL PRODUCTION (KWH/DAY)	DIESEL FUEL CONSUMED (GALLONS/DAY)	POLYMER CONSUMED (LB/DAY)
WAS Thickening			10,100	-10,000		300
Anaerobic Digestion	2474		25,200	25,200		
Mechanical Dewatering			8,100	-8,100		
Truck Transport(2)			---	---	690	3,500
Pipeline from Plant No. 1 to Plant No. 2			1,200	-1,200		
Air/Drying Composting			700	-700	1,500	
Sidestream Processing			400	-400		
TOTAL	2474		45,700	-45,700		3,800

(1) Energy requirements for digester heating are assumed to be supplied by waste heat sources.
 (2) Trucking of dewatered sludge to Round Canyon.

facilities located at the Joint Works. However, the digester gas shown in Table VI-32 would be used in internal combustion engines to drive pumps and motors.

Combustion of digester gas in internal combustion engines is not a direct result of the proposed program. The values shown for digester gas production are however provided for informational purposes.

It can be seen from Table VI-32 that insufficient electrical energy is produced to enable energy self-sufficient sludge processing. It has been assumed that the estimated deficit of 45,700 kilowatt hours per day would be obtained from the Southern California Edison electrical utility system.

In addition to electrical consumption, projected consumption of diesel fuel for trucking operations and polymer consumption for conditioning of the sludge are also reported.

PHASE III OPTIONS

Phase III options provide identification of currently indicated long-range alternatives. These have been defined from information available at the time of program development. It is recognized that new information may become available during Phase III. On a regional basis, the Phase II facilities that will be constructed by the City of Los Angeles and Los Angeles County Sanitation Districts will provide information for use by OCSD. Additionally, there may be potential for further development of the JPL-ACTS process. For the Orange County Sanitation Districts, reasonable Phase III options appear to be continuation of the Round Canyon composting/air drying facilities, or complete reliance on a thermal processing system such as dehydration/thermal processing for energy recovery or the JPL-ACTS wastewater treatment process.

For purposes of evaluation, the dehydration/thermal processing system defined for the City of Los Angeles (CLA) and L. A. County Sanitation Districts (LACSD) has been assumed. OCSD would utilize information developed by CLA and LACSD during Phase II when considering this option.

Projected sludge loadings for Phase III options are given in Table VI-33 and accommodate all sludge loads from primary treatment of 280 MGD of wastewater and secondary treatment of all primary effluent. With respect to the level of secondary treatment that may ultimately be required, the Phase III options would accommodate sludges produced by "full secondary" treatment.

The Phase III options represent an upper limit for sizing of the Phase II facilities and provide flexibility for shifting to an energy recovery operation.

TABLE VI-33

**POTENTIAL MAXIMUM SLUDGE LOADING ON PHASE III FACILITIES
ORANGE COUNTY SANITATION DISTRICTS**

Year 2000 PS Plus WAS From Full Secondary Treatment at Joint Works

<u>PROCESS</u>	<u>FEED SLUDGE RATE (DRY TONS PER DAY) (a)</u>			<u>REMARKS</u>
	<u>PRIMARY</u>	<u>WAS</u>	<u>BLEND</u>	
<u>LOADINGS COMMON TO ALL TRAINS</u>				
Raw Sludge to Digestion	280	180		Includes effect of side-stream to headworks.
Digested Sludge to Dewatering	180	140	320	
Output from Dewatering			300	Assumes 95 percent capture.
<u>DEHYDRATION AND ENERGY RECOVERY</u>				
Dehydration			300	
Thermal Processing			300	
Char/Ash to Landfill			105	Assumes total fixed carbon burnout. Would be about 130 dtpd with reduced burnout efficiency.
<u>COMPOST/AIR DRY AT ROUND CANYON</u>				
Composting(b)			300	
Landfill(c)			205-300	Lower values assumes 50 percent VS content and 50 percent VS loss during composting. Higher value assumes air drying is used in place of composting, assume no VS loss.

(a) All sludge tonnages rounded up to nearest dry tons per day (dtpd).

(b) Actual sludge loadings may be increased by about 65 to 80 dtpd if digested sludge from other Orange County agencies is processed at the facility.

(c) Tonnages would be about 250 to 380 dtpd if other Orange County sludges are included.

Analysis of Phase III options provides a description of the maximum potential environmental impacts that might be expected (1) if full secondary treatment of other factors necessitate expansion of Phase II facilities beyond the loadings described earlier, or (2) if the sludge management program shifted to an energy recovery system.

Quantitative information for the Phase III options is provided in the following sections and was developed using the same factors as were used in the development of quantitative information for the Phase II facilities. It has been assumed that each option would process the entire Phase III sludge load for purposes of analysis. Obviously, such a situation would not occur. The information given therefore represents a maximum that would result from total reliance on a single option.

Economic Characteristics: Projected costs, energy balances, and air pollutant mass emission rates were examined under Phase III conditions of year 2000 primary sludge and full secondary treatment. Results for the case of composting/air drying at Round Canyon are shown in Table VI-34, and for the case of dehydration and energy recovery in Table VI-35.

Capital costs for composting/air drying at Round Canyon under Phase III conditions are estimated at about \$61,085,000 with an amortized annual cost of \$6,130,000/yr. Annual O & M expenses of about \$10,789,000/yr are projected along with a credit for digester gas production of \$3,123,000/yr, giving a net annual cost of \$13,796,000/yr.

Capital costs for full energy recovery using the dehydration/thermal processing system under Phase III conditions are estimated to be about \$91,940,000/yr with an amortized annual cost of \$8,630,000/yr. O & M costs of about \$9,973,000/yr are projected with a total credit of \$5,208,000/yr, giving a net annual cost of \$13,395,000/yr.

Air Pollutant Emissions: Table VI-36 shows projected mass emissions of air pollutants for the Phase III options. Values are shown for emissions that would directly result from the option. It has been assumed that irrespective of the options presented, capability for combustion of digester gas in internal combustion engines would be expanded as sludge production increased.

Also shown in Table VI-36 are the projected emissions that would be produced by an electrical utility to generate electricity to satisfy sludge processing demands under the Round Canyon option. For the energy recovery option, compensating emissions resulting from production of electricity by sludge processing which would otherwise be supplied by an electrical utility are shown.

TABLE VI-34

QUANTITATIVE CHARACTERISTICS OF PHASE III FACILITIES
COMPOST/AIR DRY AT ROUND CANYON
OCSD - PLANTS NO. 1 AND NO. 2 AND ROUND CANYON

Full Secondary Treatment - Year 2000 Sludge Loads

JOINT WORKS - OCSD	DAF THICKENING	ANAEROBIC DIGESTION	LIQUID STORAGE	PIPELINE TO PLANT NO. 2	MECHANICAL DEWATERING	WET CAKE STORAGE	WET CAKE TRUCK	COMPOST AIR DRY AT ROUND CANYON	COMPOST TRUCK	TOTAL
260 dry tons per day - PS										
180 dry tons per day - WAS										
DESIGN LOAD (dry tons/day) (* tons of H ₂ O/day)	190	456	316	-	316	300	300	380(a)	380	440
OPERATING LOAD (dry tons/day) (* tons of H ₂ O/day)	190	456	316	-	316	300	300	380(a)	380	440
SIZING										
LAND AREA REQUIRED (acres)	0.8	4.6	0.5		1.4	0.6	-	290(b)		298
EMPLOYEES (No. per 24 hrs)	9	12	-	-	12	-	22	16		71
POLYMER USED (lbs/day)	600				4400					5000
ISOPAR L USED (gal/day)					1.5					1.5
O ₂ FOR RECYCLE (tons/day)										
ENERGY										
ELECTRICITY USED (KWH/DAY)	18900	32100		2000	11300			1000		65300
ELECTRICITY PRODUCED (KWH/DAY)										
DIESEL FUEL USED (gal/day)							860	1810		2670
O ₂ FOR RECYCLE (KWH/DAY)					500					500

(a) Included 80 dtpd sludge input from other Orange County Agencies.
(b) Includes buffer land.

TABLE VI-34 (Continued)

QUANTITATIVE CHARACTERISTICS OF PHASE III FACILITIES
COMPOST/AIR DRY AT ROUND CANYON
OCSD - PLANTS NO. 1 AND NO. 2 AND ROUND CANYON

Full Secondary Treatment - Year 2000 Sludge Loads

JOINT WORKS - OCSD	DAF THICKENING	ANAEROBIC DIGESTION	LIQUID STORAGE	PIPELINE TO PLANT NO. 2	MECHANICAL DEWATERING	WET CAKE STORAGE	WET CAKE TRUCK	COMPOST AIR DRY AT ROUND CANYON	COMPOST TRUCK	TOTAL
260 dry tons per day - PS										
180 dry tons per day - WAS										
CAPITAL COST (\$000)										
LAND	0	0	0	0	0	0	0	6960	0	6960
PROCESS STRUCTURAL	5903	12455	2420	1512	8728	5662	2411	14623	411	54125
TOTAL CAPITAL	5903	12455	2420	1512	8728	5662	2411	21583	411	61085
TOTAL ANNUAL CAPITAL	552	1154	226	141	816	529	586	2016	100	6130
OPERATIONS AND MAINTENANCE COST (\$000)	1182	1172	-	27	4217	-	1511	1547	1133	10789
CREDITS (\$000)										
SALE OF COMPOST										
VALUE OF FUEL		3123								3123
VALUE OF ELECTRICITY		3123								3123
TOTAL ANNUAL CREDITS										
NET ANNUAL O & M COST (\$000/YR)	1182	-1951	-	27	4217	-	1511	1547	1133	7666
TOTAL NET ANNUAL CAPITAL AND O & M COST (\$000/YR)	1734	-787	226	168	5033	529	2097	3563	1233	13796
TOTAL ANNUAL COST/TON OF DRY FEED (\$/TON)	25.0	-4.7	2.0	-	43.6	4.8	19.2	25.7	8.9	85.9(c)

(c) Based on OCSD sludge contribution only.

TABLE VI-35

QUANTITATIVE CHARACTERISTICS OF PHASE III FACILITIES
DEHYDRATION AND ENERGY RECOVERY
OCSD - PLANTS NO. 1 AND NO. 2

Full Secondary Treatment - Year 2000 Sludge Loads

JOINT WORKS - OCSD	DAF THICK- ENING	ANAEROBIC DIGESTION	LIQUID STORAGE	PIPELINE TO PLANT No. 2	MECHANICAL DEWATERING	WET CAKE STORAGE	C-G DRYING	THERMAL PRO- CESSING	CHAR/ ASH TRUCK	TOTAL
260 dry tons per day - PS										
180 dry tons per day - WAS										
DESIGN LOAD (dry tons/day)(a) (* tons of H ₂ O/day)	190	456	316	-	316	300	300	300	105	440
OPERATING LOAD (dry tons/day)(b) (* tons of H ₂ O/day)	190	456	316	-	316	300	300	300	105	440
SIZING										
LAND AREA REQUIRED (acres)	0.8	4.6	0.5	-	1.4	0.6	0.8	1.4	-	10.1
EMPLOYEES (No. per 24 hrs)	9	12			12		8	5	2	48
POLYMER USED (lbs/day)	600				4400					5000
ISOPAR L USED (gal/day)							830			830
O ₂ FOR RECYCLE (tons/day)					1.5		1.2			2.7
ENERGY										
ELECTRICITY USED (KWH/DAY)	18900	32100		2000	11300		33200	23900		121400
ELECTRICITY PRODUCED (KWH/DAY)								142800		142800
DIESEL FUEL USED (gal/day)									90	90
O ₂ FOR RECYCLE (KWH/DAY)					450			350		800

(a) Design load refers to the tonnage of solids or water used for estimation of capital costs.

(b) Operating load refers to the tonnage of solids or water used for estimation of O & M costs.

TABLE VI-35 (Continued)

QUANTITATIVE CHARACTERISTICS OF PHASE III FACILITIES
DEHYDRATION AND ENERGY RECOVERY
OCSD - PLANTS NO. 1 AND NO. 2

Full Secondary Treatment - Year 2000 Sludge Loads

JOINT WORKS - OCSD	DAF THICK- ENING	ANAEROBIC DIGESTION	LIQUID STORAGE	PIPELINE TO PLANT NO. 2	MECHANICAL DEWATERING	MET CAKE STORAGE	C-G DRYING	THERMAL PRO- CESSING	CHAR/ ASH TRUCK	TOTAL
260 dry tons per day - PS										
180 dry tons per day - WAS										
CAPITAL COST (\$000)										
LAND	0	0	0	0	0	0	0	0	0	0
PROCESS AND STRUCTURAL	5903	12455	2420	1512	8728	5662	27585	27426	249	91940
TOTAL CAPITAL	5903	12455	2420	1512	8728	5662	27585	27426	249	91940
TOTAL ANNUAL CAPITAL	552	1164	226	141	816	529	2578	2563	61	8630
OPERATIONS AND MAINTENANCE COST (\$000), TOTAL ANNUAL CREDITS (\$000)	1182	1172	-	27	4217	-	2018	1098	259	9973
SALE OF COMPOST										
VALUE OF FUEL		3123								
VALUE OF ELECTRICITY		3123						2085		
TOTAL ANNUAL CREDITS								2085		5208
NET ANNUAL O & M COST (\$000/YR)	1182	-1951	-	27	4217	-	2018	-987	259	4765
TOTAL NET ANNUAL CAPITAL AND O & M COST (\$000/YR)	1734	-787	226	168	5033	529	4596	1576	320	13395
TOTAL ANNUAL COST/TON OF DRY FEED (\$/TON)	25.0	-4.7	2.0	-	43.6	4.8	42.0	14.4	8.3	83.4

TABLE VI-36

ESTIMATED AIR POLLUTANT EMISSIONS FOR PHASE III OPTIONS ORANGE COUNTY SANITATION DISTRICTS

Year 2000 PS Plus WAS From Full Secondary Treatment
(All values are in pounds per day)

PROCESSES	ROUND CANYON COMPOST/AIR DRY					ENERGY RECOVERY				
	HC	CO	SOx	NOx	TSP	HC	CO	SOx	NOx	TSP
REASONABLE PLANNING CASE										
Truck to Round Canyon	18	117	14	88	10					
Composting/Air Drying	45	287	34	217	24					
Truck to Landfill	5	31	4	23	3					
Total ⁽²⁾	70	435	55	330	40					
Thermal Processing						23	41	471	271	139
Char/Ash Truck						2	15	2	11	1
Total ⁽²⁾						25	60	475	285	140
REASONABLE WORST CASE										
Truck to Round Canyon	23	146	17	111	12					
Composting/Air Drying	57	359	43	271	30					
Truck to Landfill	6	38	5	29	3					
Total ⁽²⁾	90	545	65	415	45					
Thermal Processing						29	51	941	1353	173
Char/Ash Truck						3	19	2	14	2
Total ⁽²⁾						35	70	945	1370	175
IC ENGINES^(2,3)	3995	1230	1590	9700	255	3995	1230	1590	9700	255
EMISSIONS FROM ENERGY PRODUCTION BY UTILITY^(2,4)	15	15	180	155	30	0	0	0	0	0
EMISSION OFFSETS FROM ENERGY PRODUCTION^(2,5)						5	5	60	50	10

- (1) Emissions are from windrow turning devices.
- (2) Values rounded up to the nearest 5 pounds per day (lb/day).
- (3) Emissions from assumed continued use of digester gas in internal combustion engines which would occur irrespective of the option. Included for informational purposes.
- (4) Emissions produced by electrical utility to produce electricity to supply sludge processing demand.
- (5) Compensating emissions resulting from production of electricity by sludge processing which would otherwise be supplied by an electrical utility.

For the case of composting/air drying at Round Canyon, emissions from combustion of digester gas in IC engine drives are expected to be considerably greater than direct project emissions from sludge processing under both the reasonable design and reasonable worst cases. Direct project emissions are composed entirely of mobile sources whereas the IC engines are a stationary source.

For the case of dehydration and energy recovery, IC engines represent the major source of HC, CO, and NO_x emissions. Direct project emissions of SO_x would be greater than that from IC engines under the reasonable design case, but not the reasonable worst case. In comparing the Phase III options, it is interesting to note that direct project emissions from HC, CO, and NO_x are less for the full energy recovery option compared to the compost air/drying option (reasonable design case). SO_x and TSP emissions would be somewhat higher, however.

Ground level concentrations of pollutants expected under Phase III conditions were shown previously in Table VI-30. Projected ground level concentrations under Phase III do not differ significantly from those estimated for Phase II. Violation of the maximum 1 hour NO_x standard is predicted under Phase III conditions at both Plants No. 1 and No. 2, due primarily to emissions attributable to IC engine drives. The contribution to ground level concentration from full thermal processing is relatively small compared to the contribution for IC engines. Thermal processing by itself would not cause a violation of ambient air standards.

Transportation Requirements: Transportation requirements vary with the options.

Under the Phase III Round Canyon option, about 1,545 cubic yards per day of dewatered sludge would be transported to the Round Canyon processing site. Approximately 18,770 round trips would be made annually resulting in a total of 826,000 vehicle miles travelled (VMT) per year. Assuming 300 working days per year and 8 hours per working day; a truck interval of 4.0 minutes between trucks is calculated.

Dried sludge would be trucked from the Round Canyon processing site to the proposed Bee Canyon landfill. Under the Phase III option, about 1,084 cubic yards per day would be trucked requiring about 13,190 round trips per year resulting in about 27,000 VMT/year. Assuming 300 working days per year and 8 hours per working day, a truck interval of 5.5 minutes between trucks is calculated.

The foregoing values include an estimated 80 dry tons per day of sludge from the Southern Orange County Sanitation agencies.

Under the Phase III energy recovery options, approximately 180 cubic yards per day of char/ash would be trucked from the Joint Works. Assuming such material is

trucked to the proposed Bee Canyon Landfill, approximately 2,150 round trips would be made annually resulting in a total of about 95,000 VMT/year. Assuming 300 working days per year and 8 hours per work day; a truck interval of 34 minutes between trucks is calculated.

Public Facilities Demands: Public facilities demands for the Phase III options are presented in Table VI-37. Information on solid waste to be managed, resultant liquid sidestreams, washwater for belt press dewatering, and potable water requirements is presented.

Energy Production and Consumption: Energy requirements for the Phase III options are shown in Table VI-38. Also shown are requirements for diesel fuel, polymer and isopar (a fractionated isoparaffinic hydrocarbon used in the dehydration process). It has been assumed that capacity for combustion of digester gas would occur irrespective of options. The amount of digester gas used is provided for informational purposes.

It can be seen from Table VI-38 that about 65,800 kilowatt hours per day (KWH/DAY) of electricity would need to be purchased from the Southern California Edison electrical utility system under the Round Canyon option. Under the energy recovery option, a surplus of about 20,600 KWH/Day are projected to be available from sludge processing.

TABLE VI-37
PUBLIC FACILITIES DEMANDS FOR PHASE III OPTIONS
ORANGE COUNTY SANITATION DISTRICTS

Year 2000 PS Plus WAS From Full Secondary Treatment

OPTION: PROCESS	ROUND CANYON COMPOSTING/AIR DRY				ENERGY RECOVERY			
	SOLID WASTE (WTPD)(a)	SIDESTREAMS (MGD)(b)	WASHWATER (MGD)(b,g)	POTABLE WATER (MGD)(c)	SOLID WASTE (WTPD)(a)	SIDESTREAMS (MGD)(b)	WASHWATER (MGD)(b,g)	COOLING WATER POTABLE WATER (MGD)(b) (MGD)(c)
WAS Thickening	0	2.0	0	0	0	2.0	0	0.10
Anaerobic Digestion	0	0	0	0.10				
Mechanical Dewatering	0	4.2	2.1	0		4.2	2.1	
Composting/Air Drying	760	0	0	0				
Dehydration								
Thermal Processing					130(d)	0.3 (h)	0.5 0.03(h)	3.1 6.2
Compost to Landfill	760							
Ash/Char to Landfill					130(d)			
Digester Residue to Landfill	250 wtpyr(e)							
Baghouse Residue Landfill					250 wtpyr(e)			
FGD Scrubber Sludge					Included in char/ash 40(f)			

- (a) Wet tons per day (wtpd) except as otherwise indicated.
 (b) Values rounded up to the nearest 0.1 million gallons per day (MGD).
 (c) Values rounded to nearest 0.005 MGD.
 (d) Assumes some fixed carbon in ash/char.
 (e) Rounded up to nearest 50 wet tons per year (wtpyr).
 (f) Rounded to nearest 5 wtpd. Special handling may be required which may, in turn, necessitate disposal at another landfill.
 (g) Washwater required for belt press dewatering system.
 (h) Includes condensate makeup water for dehydration and steam turbine system associated with thermal processing.

TABLE VI-38
ENERGY PRODUCTION AND CONSUMPTION FOR PHASE III OPTIONS
ORANGE COUNTY SANITATION DISTRICTS

Year 2000 PS Plus WAS From Full Secondary Treatment

OPTION:	ROUND CANYON COMPOSTING/AIR DRY					DEHYDRATION AND ENERGY RECOVERY					
	Process	Gas Production(d) (mBtu/day)	Electrical Energy(a) Produced (Kilowatt hours per day)	Net Required (Kilowatt hours per day)	Diesel Fuel Used(b) (GPD)	Polymers Used(c) (LB/Day)	Gas Production(d) (mBtu/day)	Electrical Energy(a) Produced (Kilowatt hours per day)	Net Required (Kilowatt hours per day)	Diesel Fuel Used(b) (GPD)	Polymer Used(c) (LB/Day)
	WAS Thickening		18,900	-18,900		600		18,900	-18,900		600
	Anaerobic Digestion	2852	32,100	-32,100			2852	32,100	-32,100		
	Pipeline from Plant No. 1 to Plant No. 2		2,000	-2,000				2,000	-2,000		
	Mechanical Dewatering		11,300	-11,300		4,400		11,300	-11,300		4,400
	Truck Transport				860					90	
	Compost/Air Drying		1,000	-1,000	1,810						
	Dehydration							33,200	-33,200	830	
	Thermal Processing							142,800	23,900	118,900	
	Sidestream Processing		500	-500				800	-800		
	TOTALS	2852	0	65,800	-65,800	2,760	5,000	142,800	122,200	20,600	5,000

(a) All values rounded to nearest 100 Kilowatt hours per day (KWH/Day)

(b) Values rounded to nearest 10 gallons per day (GPD).

(c) Values rounded to nearest 100 pounds per day (LB/Day).

(d) Digester gas assumed to be used to operate internal combustion (IC) engines.

Energy requirements for digester heating are assumed to be supplied from waste heat sources.

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CHAPTER

VII

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CHAPTER VII

ANALYSIS OF KEY TOPICS

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CHAPTER VII

ANALYSIS OF KEY TOPICS

A number of topics dealing with the assessment of alternative sludge management projects or the proposed sludge management program were not discussed in detail in the previous chapters. Purpose of this chapter is to fill this gap and provide discussion of such topics. Topics included in the analysis are outlined as follows.

- Proposed Phase II facilities are reviewed as to their compatibility with applicable regulatory requirements. Discussion focuses on those permits or regulations which are of major importance to implementation of the proposed Phase II facilities. An overview of potential permit requirements is also provided.
- Development of air emission factors and control systems used in the assessment of alternative sludge management projects and the assessment of the proposed sludge management program is discussed.
- A discussion of energy recovery systems is provided including use of digester gas and energy recovery from thermal processing of dewatered sludges. A discussion is presented on methods available to overcome moisture problems associated with thermal processing, with particular emphasis on energy efficient dehydration. Thermal processing alternatives are discussed and mass and energy balances for a complete system of dehydration-thermal processing-energy recovery-air emission control provided.
- A number of issues relating to cost effectiveness are discussed including on-site/off-site power generation, storage requirements, redundancy, and air pollution control systems.

**REGULATORY COMPATIBILITY
OF PROPOSED FACILITIES**

REGULATORY COMPATIBILITY OF PROPOSED FACILITIES

This section describes results of a review of the compatibility of facilities proposed for construction during Phase II with applicable regulatory requirements. A more complete review of applicable regulations and permits is provided in Reference No. 1. Discussion in this section focuses on those permits or regulations which are of major importance to implementation of the proposed Phase II facilities. An overview of the potential permit requirements is also provided.

LANDFILL DISPOSAL

The State Water Resources Control Board guidelines (Ref. 2) for waste disposal to land recommend that high moisture content wastes (greater than 50 percent moisture) not be disposed with Group 2 materials at sites without either natural or artificial leachate control facilities. Puente Hills landfill is the only site proposed to receive dewatered cake during Phase II. An artificial leachate control facility is included as part of the Phase II facilities. Therefore, compliance with the State guidelines is anticipated.

The Regional Water Quality Control Board - Los Angeles Region has indicated that moisture addition should not exceed 25 gallons per cubic yard at the Puente Hills site (Ref. 3). Assuming a maximum sludge loading of 150 dtpd at 22.5 percent solids, and a present landfill loading of 6000 tpd at 600 lb/yd³, a moisture addition of about 6 gal/yd³ would result. Current waste discharge requirements permit disposal of Group 2 liquid waste at a rate of 10 gallons per cubic yard. If this is added to that expected from sludge the total is still well within the recommended limit. Furthermore, during Phase II, solid waste loading at Puente Hills is expected to increase substantially (to about 10,000 tpd est.) upon closure of Palos Verdes and Operating Industries landfills. It should be noted that attainment of this moisture loading guideline does not remove the requirement for a leachate control system.

Some composted product may be landfilled during Phase II if the material can not be marketed for any reason. Compost is generally greater than 50 percent solids content and should pose no difficulties in landfilling with other Group 2 wastes.

The Regional Water Quality Control Board - Santa Ana Region has required that sludges be at least 50 percent solids content prior to disposal with Group 2 wastes at landfill sites within the Board's jurisdiction. Material produced from the Round Canyon processing site is expected to be greater than 50 percent solids and compliance with the Board's policy is anticipated.

State Water Resources Control Board guidelines (Ref. 2) specify community incinerator ash as a Group 1 waste requiring disposal in a Class I landfill site. If char/ash from thermal processing is considered a Group 1 waste, a special permit may be required for disposal to a Class II-1 landfill. If such a permit cannot be obtained, char/ash would require disposal at a Class I facility. BKK and Calabasas landfills are the most likely Class I facilities for long term disposal.

COMPOST MARKETING

Guidelines on use of sludge based compost in bagged products or bulk sale and giveaway programs are yet to be promulgated by EPA under Section 405 of the Clean Water Act. These guidelines are expected to address both the trace metal and trace organic content of the sludges as well as requirements for pathogen quality. Since the guidelines are yet to be published, no statement regarding compliance is possible at this time. If local sludge based compost materials cannot comply with the guidelines, such material would have to be landfilled with other Group 2 wastes. Therefore, violation of any future guidelines on use of compost product is not expected as long as landfill disposal of composted sludge remains available.

It should be noted that compost produced from OCSD sludges is not recommended for distribution at this time, even in the absence of official guidelines. Heavy metal contents are quite high and generally above levels being informally considered as part of Section 405 regulations. Until such time as industrial pretreatment can reduce the heavy metal content or until Section 405 guidelines are promulgated, it is not proposed that OCSD sludges be marketed.

AIR QUALITY REGULATIONS

The Phase II facilities were reviewed as to compliance with U.S. EPA's promulgated New Source Performance Standards (NSPS) and applicable new source review requirements. New Source Performance Standards limit emissions from sludge incineration to the following: particulates, 1.30 lb/dry ton of sludge input; opacity, 20 percent; beryllium, 10 gm/24 hours; mercury, 3200 gm/24 hours. The Phase II facilities are projected to produce particulate emissions at a rate of about 0.45 lb/dry ton with an opacity considerably less than 20 percent.

Mercury concentrations for the CLA under Phase II marine secondary conditions are projected to be about 13 mg/kg. With a sludge load of 264 dtpd, the mass input rate to the furnace would be 3120 gm/day. Corresponding values for LACSD are about 5 mg/kg, a sludge load of 238 dtpd, and a mass input rate of 1080 gm/day. Most of the input mercury should volatilize at temperature conditions maintained in the thermal reactor. Some of the volatilized mercury will be removed during wet scrubbing of the flue gas. The removal rate of mercury through scrubbers installed on an incinerator at Livermore, California was found to be about 90 percent (Ref. 4) and a value of 60 percent was used in the Boston EIS (Ref. 5). Assuming a 60 percent removal the mass emission rate from the furnace would be about 1250 gm/day for the CLA and 430 gm/day for LACSD.

There is a lack of operational data on the mass emission rate of beryllium for sludge incineration systems. It has been shown that most of the beryllium in coal fuel power plants remains in the ash which is consistent with the measured boiling points for beryllium and its compounds. Furthermore, available data on LA/OMA sludge characteristics indicated that beryllium is present at less than detectable levels.

Based on the above analysis it is projected that all applicable NSPS will be achieved by the proposed Phase II facilities.

The Phase II facilities will be required to comply with new source review requirements since the South Coast Air Basin is a designated non-attainment area for ozone, carbon monoxide, nitrogen dioxide, and primary particulates. Compliance with new source review will be determined by comparison with Regulation XIII adopted by the South Coast Air Quality Management District (SCAQMD) on October 5, 1979, and as amended by the State Air Resources Board (ARB) on October 23, 1979. The provisions of this regulation apply to any new or modified stationary source which results in a net increase of any air contaminant greater than 150 lbs/day except carbon monoxide for which the increase is 750 lbs/day (Rule 1302.a). Affected sources shall offset all emission increases of all affected air contaminants times an offset factor (Rule 1307.a). The latter has a value of 1.0 to 1.2 depending on whether the facility is a modification to an existing permit unit or a new permit unit and providing the compensating emission reductions are within 5 miles of the source.

Direct project emissions include all stationary sources and in-plant mobile sources, but exclude mobile emissions from off-site sludge hauling to a landfill (Rule 1302.q, 1306.d.2). Phase II emissions should be at least partially offset by the 1978 base condition. Rule 1306.a.1 requires that emissions be accumulated from October 8, 1976, or within the last five years, whichever time period is shorter. However, existing emissions at the treatment plants have not changed significantly in recent years and the base conditions would not change significantly if averaged over a longer time period. Phase II emissions have been calculated using the maximum rated capacity as required by Rule 1306.c.1.

The Phase II facilities will produce fuels and electrical energy which will be used to satisfy power demands required for both sludge processing and upgraded levels of wastewater treatment. Both sludge processing and improved wastewater treatment are required under provisions of the Clean Water Act. Therefore, these new power demands will occur regardless of whether energy is recovered during sludge processing or not. If energy is not recovered the demands will be met by power utilities, resulting in increased levels of air emissions from local generating plants. Recovery of energy during sludge processing can be viewed, therefore, as an energy conservation measure since fossil fuels will be conserved at local electrical utilities. Rule 1308 allows offsets for emission reductions which result from energy conservation. Therefore, Phase II emissions may be offset by emissions from steam-electric power generation using fuel oil to produce an equivalent amount of net power.

Reasonable planning case emissions were used in the analysis for HC, CO, and particulates since it is believed that such levels can be reliably achieved in practice. However, reasonable worst case conditions for the thermal reactor were examined for the pollutants SO_x and NO_x . Descriptions of air emission scenarios and planning and worst case assumptions are provided in Chapter II of the environmental impact statement for each operating agency. An emission inventory for the CLA Phase II facilities (assuming H_2S removal from digester gas or equivalent in-plant reductions of SO_2 emissions) is shown in Table VII-1 for the cases of Full and Partial CCP.

With Full CCP, large emission reductions are shown for hydrocarbons and NO_x , and somewhat smaller reductions for CO, SO_x , and TSP. If the reasonable worst case conditions for SO_x and NO_x are considered, large emission reductions for NO_x are still realized, but a small increase in SO_x is shown. The increase in SO_x should be less than 150 lb/day.

TABLE VII-1

CLA PHASE II FACILITIES - COMPLIANCE WITH NEW SOURCE REVIEW REQUIREMENTS
REASONABLE PLANNING CASE CONDITIONS(c)

	EMISSIONS, LB/DAY (a)				
	HC AS CH ₄	CO AS CO	SO _x AS SO ₂	NO _x AS NO ₂	TSP
<u>Full CCP</u>					
Direct Emissions(b)	110	385	485 (885)(c)	1100 (2015)	160
Electrical Offsets	45	50	650	550	100
1978 Base(d)	<u>1935</u>	<u>595</u>	<u>220</u>	<u>4705</u>	<u>125</u>
Net increase (+) or decrease (-)	-1870	-260	-385 (+15)	-4155 (-3240)	-65
Net increase (+) or decrease (-) (No elec. offset)	-1825	-210	+265 (+665)	-3605 (-2690)	+35
<u>Partial CCP</u>					
Direct Emissions(b)	1160	620	485 (885)	3475 (4395)	215
Electrical Offsets	45	50	650	550	100
1978 Base (d)	<u>1935</u>	<u>595</u>	<u>220</u>	<u>4705</u>	<u>125</u>
Net increase (+) or decrease (-)	-820	-25	-385 (+15)	-1780 (-860)	(-10)
Net increase (+) or decrease (-) (No elec. offset)	-775	+25	+265 (+665)	-1230 (-310)	+90

- (a) All values rounded up to nearest 5 lb/day.
 (b) Includes all stationary sources, but excludes mobile emissions from char/ash hauling.
 (c) Values in parenthesis are for the reasonable worst case conditions applied to the thermal processing system only.
 (d) Includes only the emissions from onsite operation of internal combustion engines and boilers. A portion of the digester gas is used offsite at the adjacent Scattergood Steam Plant. Emissions from offsite use of digester gas were not included in the 1978 Base inventory to assure that the analysis would be conservative. Inclusion of such emissions would have the effect of increasing the 1978 Base Level.

Under the Partial CCP scenario, emission reductions for HC and NO_x are also projected but the reductions are not as large as for the full CCP case. Slight decreases in CO and TSP are predicted. Under the reasonable worst case conditions an emission reduction for NO_x is shown along with a slight increase in SO_x.

A net increase greater than 150 lb/day is not expected for any pollutant under either the Full CCP or Partial CCP cases. Therefore, it is concluded that Phase II facilities at Hyperion should comply with New Source Review Regulation XIII, subject to the interpretation of said regulations as described above and assuming H₂S removal from digester gas or equivalent in-plant reductions of SO₂ emissions. If the equivalent electrical power emissions were judged ineligible as an emission offset, the new source review threshold requirements would continue to be met for all pollutants, except SO_x for which an increase greater than 150 lb/day is projected. In this case additional emission offsets or additional in-plant SO₂ reductions may be required.

As discussed in Chapter VI, opportunities exist to further decrease direct project emissions of NO_x, SO_x, and TSP through use of innovative technologies. Considering SO_x emissions, and assuming 90 percent removal of sulfur emissions from digester gas combustion and a thermal processing outlet flue gas concentration of 20 ppm(v), direct SO_x emissions from CLA Phase II facilities (on-site sources) could be reduced to about 205 lb/day, which is less than 1978 Base emissions estimates. Similarly, if the particulate discharge from thermal processing can be reduced to 0.0005 gr/ACF, direct particulate emissions from on-site sources would be reduced to about 45 lb/day, considerably less than the 1978 Base estimate. Such emission levels appear to be achievable and are further discussed in subsequent sections of this Chapter. Based on this analysis, it would appear that new source review requirements for all pollutants could be achieved entirely from in-plant emission offsets, without consideration of electrical offsets, provided innovative control technologies perform as anticipated. Therefore, it is concluded that CLA Phase II facilities would appear to comply with New Source Review Regulation XIII, subject to interpretation of said regulation as described above, or through application of innovative control technologies in the event that electrical offsets are not allowed.

An emissions inventory for the LACSD Phase II facilities (assuming H₂S removal from digester gas or equivalent in-plant reductions of SO₂ emissions) is shown in Table VII-2. It is assumed that all three thermal processing modules are operating since this is a possible mode of operation during winter months. Significant emission reductions (from 1978 levels) for HC and NO_x are projected, and smaller reduction in SO_x and TSP. CO is shown to increase, but the increase is substantially less than 750 lb/day. Therefore, it is concluded that Phase II facilities at JWPCP should comply with New Source Review Regulation XIII, subject to the interpretation of said regulation as described above and assuming H₂S removal from digester gas or equivalent in-plant reductions of SO_x emissions. If the equivalent electrical power emissions were judged ineligible as an emission offset, new source review requirements would continue to be met for all pollutants, except SO_x for which an increase greater than 150 lb/day is projected in which case additional emission offsets or additional SO₂ reductions may be required. The particulate increase is close to 150 lb/day, but reductions in HC and NO_x could be used to further offset TSP increases according to Rule 1308.d.

TABLE VII-2

LACSD PHASE II FACILITIES - COMPLIANCE WITH NEW SOURCE REVIEW REQUIREMENTS
REASONABLE PLANNING CASE CONDITIONS (c)

375 dtpd to Thermal Processing

	EMISSIONS, LB/DAY (a)				
	HC AS CH ₄	CO AS CO	SO _x AS SO ₂	NO _x AS NO ₂	TSP
Direct Emissions(b)	815	835	580 (c) (1105)	3255 (4465)	265
Electrical Offsets 1978 Base (d)	65 <u>1935</u>	75 <u>605</u>	985 <u>90</u>	835 <u>4765</u>	145 <u>135</u>
Net increase (+) or decrease (-).	-1180	+215	-490 (+30)	-2300 (-1135)	-10
Net increase (+) or decrease (-) (No elec. offsets)	-1115	+290	+495 (+1015)	-1465 (-300)	+135

(a) All values rounded up to nearest 5 lb/day.

(b) Includes all stationary sources and on-site mobile sources, but excludes mobile emissions from wet cake and char/ash hauling to landfill.

(c) Values in parenthesis are for the reasonable worst case conditions applied to the thermal processing system only.

(d) Includes only those emissions from onsite operation of IC engines and boilers. A portion of the digester gas is used offsite by an adjacent oil refinery. Emissions from offsite use of digester gas were not included in the 1978 Base inventory to assure that the analysis would be conservative. Inclusion of such emissions would have the effect of increasing the 1978 Base Level.

Opportunities also exist to further decrease direct project emissions from LACSD Phase II facilities. Considering SO_x emissions, and assuming 90 percent removal of sulfur emissions from digester gas combustion and a thermal processing outlet flue gas concentration of 20 ppm(v), direct SO_x emissions from on-site sources could be reduced to about 180 lb/day, which is less than a 150 lb/day increase over the 1978 Base condition. Similarly, if the particulate discharge from thermal processing can be reduced to 0.0005 gr/ACF, direct particulate emissions from on-site sources would be reduced to about 120 lb/day, essentially equivalent to the 1978 Base condition. Based on this analysis, it would appear that new source review requirements for all pollutants could be achieved entirely from in-plant emission offsets, without consideration of electrical offsets, provided innovative control technologies perform as anticipated. Therefore, it is concluded that LACSD Phase II facilities would appear to comply with New Source Review Regulation XIII, subject to interpretation of said regulation as described above, or through application of innovative control technologies in the event that electrical offsets are not allowed.

The emission inventory for OCSD Phase II facilities is shown in Table VII-3. Projected emissions for continued use of IC engines are not shown. For purposes of new source review, it is assumed that all digester gas would be used in facilities for which operating permits have been granted and that no modification of these facilities would be required. Emissions from the compost operation at Round Canyon have been separated from those of the JPL/ACTS process. Since the JPL/ACTS demonstration does not depend on or affect the operation at Round Canyon, it is assumed to not be part of the same stationary source (Rule 1302.q).

The Round Canyon facility should meet new source review requirements for all pollutants except NO_x for which an increase slightly above 150 lb/day is projected. All emissions at Round Canyon would result from on-site operation of mobile equipment. The emissions at the Round Canyon site are considerably higher than other mobile emissions, including those from wet cake hauling. This prompted a review of design criteria developed for the windrow composting operation. A rather high rate of fuel consumption was assumed in order to provide a conservative estimate of energy use. Revised estimates indicate that fuel consumption can likely be reduced below present estimates and that NO_x should be below 150 lb/day. If this cannot be achieved, possible emission offsets include: (1) additional emission control devices or modifications on the mobile sources at Round Canyon to reduce the air emission factor; and (2) emission reductions from stationary sources at either Plant No. 1 and 2. Therefore, it is concluded that Phase II facilities for OCSD at Round Canyon would appear to comply with New Source Review Regulation XIII, subject to the interpretation of said regulation as described above, and subject to possible attainment of additional offsets for NO_x emissions.

The JPL/ACTS demonstration would appear to comply with all new source review requirements under the reasonable design case. Under the reasonable worst case assumptions, mass emission rates for NO_x and SO_x are projected to exceed 150 lb/day. In this case, emission offsets would be required to comply with Regulation XIII. Sufficient offsets are projected to be available within the treatment plant.

It should be noted that exemptions from requirements of Regulation XI-II are available for resource conservation and energy projects under certain conditions

TABLE VII-3

**OCSD PHASE II FACILITIES - COMPLIANCE WITH NEW SOURCE REVIEW REQUIREMENTS
REASONABLE PLANNING CASE CONDITIONS (b)**

	EMISSIONS, LB/DAY (a)				
	HC	CO	SO _x	NO _x	TSP
	AS CH ₄	AS CO	AS SO ₂	AS NO ₂	
Compost/Air Dry at Round Canyon	41	260	31	196	22
JPL/ACT Demonstration	2	3	36 (215)(b)	21 (207)	11

- (a) Includes all stationary sources and on-site mobile sources, but excludes mobile emissions from wet cake transport to Round Canyon and compost hauling to a landfill.
- (b) Values in parenthesis are for the reasonable worst case conditions applied to the thermal processing system only.

(Rule 1304.e). The conditions under which an exemption can be granted are rather complex, but do apply to cogeneration projects using biomass-derived fuels for useful energy generation. It is necessary that the applicant establish by modelling that the new source will not cause a new violation or make measurably worse an existing violation of any national ambient standard at the point of maximum ground level impact. Results of air dispersion modelling indicated that the DFTP and CCP would result in rather small incremental increases in the maximum ground level concentration. Predicted ground level concentrations are generally less than 10 percent of the most stringent ambient air standard, except for NO_x where the increase is about 20 to 30 percent. Whether proposed Phase II facilities would qualify for an exemption is not known at this time.

It should be kept in mind that the foregoing evaluation has not considered detailed design of emission control systems but is based upon planning information. Final determination of regulatory compliance rests with the respective regulatory agencies and will be based upon the facts available at the time of permit application. More detailed design information, better estimates of baseline emissions, interpollutant offsets, are among the factors which affect the foregoing conclusions. Additionally, the South Coast Air Basin, is not designated a nonattainment area for SO_2 . However, since a fraction of the SO_2 emission is a precursor of particulates, some offset requirements may be specified for SO_2 . The present analysis was unable to consider this potential due to lack of information regarding interpollutant tradeoff requirements. The analysis may be somewhat conservative with respect to SO_2 emissions. Thus, the foregoing evaluation should not be viewed as the final determination of regulatory compatibility and is subject to the development of new information.

Besides the New Source Performance Standards and the New Source Review, there are also general prohibitions under Regulation IV of the AQMD. Emissions from the CCP and DFTP for CLA and LACSD were examined for compliance with the Prohibitions. Results of the evaluation are presented in Table VII-4. It should be noted that this assessment was conducted by LA/OMA for planning purposes and was based on interpretation of AQMD regulations. It does not imply an assessment by AQMD for permitting purposes.

For particulate matter (TSP), prohibitions under Rules 404, 405, 409, 475a(3) and 476a(2) would apply. In general, the most stringent mass discharge limit is 11 lb/hr of TSP as defined in Rule 475 and 476. It would be applicable to both the CCP and DFTP, but it would be met by both units with a comfortable margin. The most stringent concentration limit is 0.01 gr/SCF (dry) as defined in rule 476. The CCP would be able to meet the limit, but the DFTP would not based on the "planning case" emission factor of 0.01 gr/ACF at 400°F. However, a much lower emission factor appears achievable with use of innovative particulate control systems. Rule 476 further states that there is no violation unless both the mass and concentration limits for TSP are exceeded together. Therefore, the DFTP would still comply with the Rule through meeting the mass limit. The TSP concentration limits in Rule 404 and 409 are much less stringent and the DFTP would meet them with a safe margin.

A concentration limit for carbon monoxide of 2000 ppm is defined in Rule 407. This limit can be met by both the CCP and DFTP with a wide margin.

TABLE VII-4

COMPLIANCE STATUS OF PHASE II FACILITIES WITH AQMD PROHIBITORY REGULATIONS

REGULATION	DESCRIPTION	DISCHARGE LIMITS OR ALLOWABLE EMISSIONS	PROJECTED EMISSIONS ⁽¹⁾	REMARKS
RULE 404	TSP - Conc. Conc. Limits Based on Vol. Discharged	CLA 0.0513 gr/SCF LACSD 0.0474 gr/SCF	0.018 gr/SCF	CCP - Exempted Specifically DFTP - Complies
RULE 405	TSP - MT. Mass limit based on process MT.	CLA 346 lb/day LACSD 372 lb/day	DFTP 117 lb/day CLA 155 lb/day LACSD	CCP - Not Applicable DFTP - Complies
RULE 407	CO	2000 ppm	CCP Negligible DFTP 10 ppm	CCP & DFTP - both comply
RULE 409	TSP	0.1 gr/SCF	CCP 0.002 gr/SCF DFTP 0.018 gr/SCF	CCP - DFTP - both comply
RULE 431.1	Sulfur Content of Gaseous fuel	80 ppm H ₂ S (natural gas) 800 ppm H ₂ S (refinery gas)		CCP - Digester Gas Exempted DFTP - Not Applicable
RULE 474	Fuel Burning Equipment -NO _x	555 mm BTU/hr heat input rate or above		CCP & DFTP - Not Applicable
RULE 475	Electric Power Generating Equipment	Max. rating 10 net MW and above		DFTP - Not Applicable
		80 ppm NO_x 1.7 lb NO_x/net MWh (CLA 416 lb/day) (LACSD 503 lb/day) 11 lb/hr TSP 0.01 gr TSP/SCF	212 ppm 870 lb/day CLA 1360 lb/day LACSD 1.7 lb/hr	CCP - additional NO _x reduction reqd. TSP limits met.
RULE 475.1	Reduction of NO _x		0.002 gr/SCF	CCP & DFTP exempted due to use of biomass-derived fuel
RULE 476	Steam Generating Equipment	Max. heat input rate of 50 mm BTU/hr. and above		CCP - additional NO _x reduction required; superseded by Rule 475a(1), TSP limits met
		125 ppm NO_x (CCP) 225 ppm NO_x (DFTP) 11 lb/hr TSP 0.01 gr TSP/SCF	212 ppm NO _x 286 ppm NO _x CCP 1.7 lb/hr CLA 2.7 lb/hr LACSD DFTP 6.2 lb/hr CLA 8.1 lb/hr LACSD CCP 0.002 gr TSP/SCF DFTP 0.018 gr TSP/SCF	DFTP - Additional NO _x reduc- tion required. TSP limits met due to compliance with mass limit.

1. Reasonable planning case emission levels were assumed for all pollutants and processes, except NO_x from DFTP, for which the reasonable worst case is assumed.

The sulfur content of gaseous fuel is limited by Rule 431.1. However, digester gas is explicitly exempted from the Rule.

Rules 474, 475a(1), (2), 475.1 and 476a(1) apply to the discharge of NO_x compounds. Capacities of CCP and DFTP under Phase II Facilities would be below the cut-off limit for Rule 474, and the rule would not apply. Rule 475.1 on the phased reduction of NO_x emission would also not be applicable, due to the provision exempting biomass-derived fuels from the Rule. However, Rule 475 would be applicable to the CCP, and Rule 476 probably to both CCP and DFTP.

Under Rule 475, electrical generating equipment rated at more than 10 net megawatts is limited to 80 ppm of NO_x (gaseous fuel) and 1.7 lb of NO_x per net megawatt hour of electricity generated. Using the present emission factor of 0.30 lb NO_x/mm BTU, the CCP would exceed both the concentration and mass emission limits. It would appear that both limits could be met by use of additional control systems such as water injection to reduce combustion temperature and/or selective catalytic or non-catalytic NO_x reduction.

Rule 476 applies to steam generating equipment and would limit the CCP and DFTP to 125 and 225 ppm NO_x, respectively. For the CCP, the NO_x concentration requirement is to some extent superseded by corresponding requirements in Rule 475a(1). However, the DFTP for the Phase II facilities would be governed by Rule 476, though exempted from Rule 475. Under the reasonable worst case scenario, an additional 16 percent NO_x reduction is anticipated to be required for the DFTP to meet this Rule. Such a reduction appears achievable by operation of the thermal processing reactor in a uniform steady-state manner to maximize NO_x reductions achieved by selective non-catalytic reduction.

In summary, all the Prohibitory Regulations are expected to be met by the CCP and DFTP, with the exception of NO_x limits for CCP and DFTP. It is anticipated that compliance with NO_x regulations can be achieved through use of additional control systems or improved performance of assumed control systems.

OFF-SITE COMPOSTING AT ROUND CANYON

Waste discharge requirements that might be imposed at the Round Canyon site were assessed based on established discharge requirements at the present Coyote Canyon Landfill site and discussions with staff of the Regional Water Quality Control Board - Santa Ana Region. The following discharge specifications may be typical of those which may be applied at Round Canyon:

1. Facilities must be provided to preclude off-site drainage from entering the sludge processing and/or storage areas.
2. On-site runoff which is likely to be contaminated by contact with sludge or sludge based products must be collected and stored. At Coyote Canyon, the drainage system must be capable of storing the storm runoff resulting from a 4.8 inch rainfall in a 24-hour period. The latter is believed to be approximately a 10 year frequency storm and it is required that storage sumps be pumped promptly to provide adequate runoff capacity. Storage requirements at Round Canyon may be greater than that required at Coyote Canyon, particularly if on-site disposal by reuse and evaporation is anticipated.

3. At Coyote Canyon a 6-inch base material with a permeability not greater than 10^{-6} cm/sec is specified. This may not be required at Round Canyon since the site does not overlay refuse or other decomposable material.
4. Sludge processing and storage areas shall be protected from washout or erosion resulting from a 100 year frequency flood.
5. Discharge of stored and treated runoff may be precluded due to a Regional Board policy against direct discharge into any water body tributary to a bay or estuary. On-site storage and reuse or conveyance off-site by truck or pipeline to a wastewater treatment plant are the most likely alternatives if direct discharge is precluded.

POTENTIALLY REQUIRED PERMITS

Various permits are expected to be required for construction and operation of proposed Phase II facilities. An overview of potential requirements for each of the LA/OMA operating agencies follows.

City of Los Angeles

- Permits to construct and operate facilities from the South Coast Air Quality Management District.
- Waste discharge requirements for disposal of ash/char from the Los Angeles Regional Water Quality Control Board if such requirements currently applicable to the selected disposal site(s) are not adequate.
- Such permits as may ensue from federal regulations related to the recycling of composted sludge.
- Coastal zone development permit from the State Coastal Commission if current permits are not adequate.

Los Angeles County Sanitation Districts

- Permits to construct and operate facilities from the South Coast Air Quality Management District.
- Waste discharge requirements for disposal of ash/char from the Los Angeles Regional Water Quality Control Board if such requirements currently applicable to the selected disposal site(s) are not adequate.
- Such permits as may ensue from federal regulations related to the recycling of composted sludge.
- Coastal zone development permit from the State Coastal Commission if current permits are not adequate.

Orange County Sanitation Districts

- Permits to construct and operate facilities at Round Canyon from the South Coast Air Quality Management District.
- Waste discharge requirements for disposal of composted/air dried sludge from the Santa Ana Regional Water Quality Control Board if such requirements applicable to the selected disposal site(s) are not adequate.
- Waste discharge requirements from the Santa Ana Regional Water Quality Control Board governing potential discharges from site operations.
- Land use permits for the Round Canyon site from the County of Orange and/or the City of Irvine.
- Coastal zone development permit for activities at the Joint Works from the State Coastal Commission if current permits are not adequate.

**AIR EMISSION FACTORS
AND CONTROL SYSTEMS**

AIR EMISSION FACTORS AND CONTROL SYSTEMS

Air emission factors used in the assessment of alternative sludge management projects and the assessment of the proposed sludge management program are described in this section. Emission factors for total suspended solids (TSP), nitrous oxides (NO_x), sulfur oxides (SO_x), hydrocarbons (HC), and carbon monoxide have been developed for various unit processes.

The factors presented represent the culmination of efforts which extended over a two year period. Sources of information included literature reviews, actual field and laboratory testing, communications with manufacturers, and discussions with air quality regulatory and planning agencies including the South Coast Air Quality Management District (SCAQMD), the California Air Resources Board (ARB), and EPA Region IX. The factors presented have undergone considerable evolution since initiation of the effort as the result of numerous reviews and better information. In the case of thermal processing, pilot scale gasification tests were conducted to obtain information for use in development of the emission factors for NO_x and SO_x .

Except for thermal processing, air emission factors given in Table VII-5 are expressed as pounds per million BTU (lb/mmBTU) of fuel consumed. In developing estimates of mass emission rates of pollutants, each unit process in the sludge treatment train was analyzed to determine the estimated daily fuel consumption. Fuel consumption values were then multiplied by the appropriate emission factor to give the mass emission rate of the individual pollutants. In the case of thermal processing, mass and energy balances were performed around the thermal reactor to determine the estimated flue gas volume and mass. These values were then multiplied by the appropriate emission factors to give the mass emission rate of the individual pollutants from thermal processing.

In all cases, the air emission factors are believed to be attainable with reasonably good engineering design and operating practice. This does not imply that lower emission factors are not attainable. Measures for reduction of the respective emission factors are also outlined in Table VII-5 for each of the unit processes. It should be noted that the emission factors reported in Table VII-5 do not reflect the mitigation measures that have been identified.

The emission factors for the thermal processing systems were reviewed by a firm specializing in the field of air pollution control systems. (Ref. 2) Control device options for NO_x , TSP, and SO_x emissions from thermal processing were analyzed. This evaluation has disclosed that:

- Fabric filter baghouses, electrostatic baghouses, and electrostatic precipitators are viable particulate control options which should meet or exceed the emission factor of 0.01 grains per actual cubic foot (gr/ACF) at 400°F given in Table VII-5. Electrostatic baghouses are a recent innovation in fabric filter technology which employ electrostatic augmentation and have been commercially available for about a year. This system reportedly can achieve an outlet concentration of 0.0005 gr/ACF at 400°F.

TABLE VII-5

EMISSION FACTORS USED BY LA/OMA FOR ESTIMATING EMISSIONS FROM VARIOUS FACILITIES

(Units - lb/mm BTU of Fuel, Except as Noted)

NO_x AS NO₂, SO_x AS SO₂, CO AS CO, and HC AS CH₄

COMBINED CYCLE PLANT (CCP)		
Process Description =	Digester gas fueled gas turbine with waste heat boiler.	
Emission Controls =	None assumed.	
Mitigation Measures =	Water injection to reduce NO _x formation, selective catalytic or non-catalytic NO _x reduction H ₂ S removal from digester gas, SO _x scrubbing from flue gas.	
POLLUTANT	FACTOR	REMARKS
TSP	0.014	AP-42 (Ref. 3), Table 3.3.1-2
NO _x	0.30	AP-42, Table 3.3.2-1. Used in place of factor from Table 3.3.1-2 since latter includes internal combustion engines.
SO _x	0.0446 ^(a) 0.149 ^(b) 0.446 ^(c)	Based on average H ₂ S content in digester gas of 150 ppm (v) for JWPCP (Ref. 34, 35), 500 ppm (v) for Hyperion, and 1500 ppm (v) for OCSO. Assumes 600 BTU/ft ³ of digester gas.
CO	0.120	AP-42, Table 3.3.2-1
HC	0.0307	AP-42, Table 3.3.2-1
STEAM BOILER (DIGESTER GAS)		
Process Description =	Steam boilers are required for digester heating and as standby for dehydration and thermal pretreatment processes. All boilers are assumed to be digester gas fired.	
Emission Controls =	No flue gas control equipment is assumed.	
Mitigation Measures =	H ₂ S removal from digester gas, scrubbing of flue gas for particulate and partial NO _x and SO _x removal.	
POLLUTANT	FACTOR	REMARKS
TSP	0.014	AP-42, Table 1.4-1 for industrial process boilers, assumes 1000 BTU/SCF for natural gas.
NO _x	0.120	AP-42, Table 1.4-1, industrial process boilers. Lower end of range used based on source testing and lower adiabatic flame temperature.
SO _x	0.0446 ^(a) 0.149 ^(b) 0.446 ^(c)	Same as for CCP.
CO	0.017	AP-42, Table 1.4-1 industrial process boilers.
HC	0.003	AP-42, Table 1.4-1 industrial process boilers.
STEAM BOILER (LANDFILL GAS)		
Process Description =	Disposal of wet sludge cake in a refuse landfill could result in enhanced generation of landfill gas. Such gas was assumed to be fired in a steam boiler.	
Emission Controls =	No flue gas control equipment is assumed.	
Mitigation Measures =	H ₂ S removal from landfill gas, scrubbing of flue gas for particulate and partial NO _x and SO _x removal.	
POLLUTANT	FACTOR	REMARKS
TSP	0.014	Same as digester gas fired boiler.
NO _x	0.120	Same as digester gas fired boiler.
SO _x	0.024 ^(a) 0.080 ^(b) 0.240 ^(c)	About 54 percent of enhanced gas production is projected to result from continued decomposition of sludge (Ref. 41). Since landfill gas derived from refuse contains little sulfur, the emission factors were prorated according to the S content of the respective digester gases.
CO	0.017	Same as digester gas fired boiler.
HC	0.003	Same as digester gas fired boiler.

TABLE VII-5 (CON'T)

EMISSION FACTORS USED BY LA/OMA FOR ESTIMATING EMISSIONS FROM VARIOUS FACILITIES

(Units - lb/mm BTU of Fuel, Except as Noted)

TRUCKS AND MOBILE EQUIPMENT		
Process Description =	Diesel engine powered mobile equipment.	
Emission Controls =	Applicable Federal and State emission controls are assumed.	
Mitigation Measures =	None.	
POLLUTANT	FACTOR	REMARKS
TSP	0.106	Based on review of data for several sources (Ref. 4, 5, 20, 28). Final factor based on Tables 5-4, 5, 6, and 8 from Data Base and Documentation for Estimating Emissions from Motor Vehicles in California, California ARB, 1977, (Ref. 4).
NO _x	0.966	Same as for TSP.
SO _x	0.152	Same as for TSP.
CO	1.28	Same as for TSP.
HC	0.202	Same as for TSP.
RECIPROCATING ENGINES		
Process Description =	Stationary, internal combustion engines powered with digester gas.	
Emission Controls =	None assumed beyond applicable Federal and State emission controls.	
Mitigation Measures =	H ₂ S removal from digester gas, selective catalytic NO _x reduction (SCR), catalytic oxidation of hydrocarbons.	
POLLUTANT	FACTOR	REMARKS
TSP	0.089	Source test data at JWPCP (Ref. 45)
NO _x	3.40	AP-42, Table 3.3.2-1, assumes 1000 BTU/SCF for natural gas.
SO _x	0.0446 (a) 0.149 (b) 0.446 (c)	Same as for CCP.
CO	0.43	AP-42, Table 3.3.2-1
HC	1.40	AP-42, Table 3.3.2-1
POWER GENERATION BY ELECTRICAL UTILITY		
Process Description =	Conventional steam electric power generation using fuel oil.	
Emission Controls =	With the exception of SO _x , emission factors are based on 1974 operations of Los Angeles County power plants and reflect emission controls applicable at that period.	
Mitigation Measures =	None.	
POLLUTANT	FACTOR	REMARKS
TSP	0.0386	Based on review of data from several sources (Ref. 3, 5, 17, 46). Final factor based on Table XLVIII, Air Quality Handbook for Environmental Impact Reports, SCAQMD, 1977, (Ref. 5).
NO _x	0.221	Same as for TSP.
SO _x	0.261	Based on 0.25 percent S by weight in fuel oil as per existing requirements.
CO	0.0193	Same as for TSP.
HC	0.0173	Same as for TSP.

TABLE VII-5 (CON'T)

EMISSION FACTORS USED BY LA/OMA FOR ESTIMATING EMISSIONS FROM VARIOUS FACILITIES

(Units - lb/mm BTU of Fuel, Except as Noted)

THERMAL PROCESSING		
Process Description =	Direct fired thermal processing in a reactor of the multiple hearth furnace (MHF) or fluid bed type. The furnace may be operated in a starved air mode with resultant flue gas combusted in an afterburner followed by a waste heat boiler.	
Emission Controls =	A fabric filter or equivalent for particulate control, flue gas desulfurization by chemical scrubbing for SO _x control, and selective non-catalytic NO _x reduction (SNCR) using NH ₃ injection are assumed.	
Mitigation Measures =	Increased particulate removal such as by decreased baghouse loading or use of electrostatically augmented baghouses. Increased SO _x removal in FGD system. Selective catalytic reduction of NO _x in place of non-catalytic reduction, or design for increased removal efficiency in a non-catalytic system.	
POLLUTANT	FACTOR	REMARKS
TSP	0.01 grains/ACF @ 400°F	Based on literature review (see cited references), data supplied by baghouse manufacturer (Ref. 21, 25), and consultant review (Ref. 2).
NO _x (sludge only & sludge/manure)	Uncontrolled 1.27 lb/ton of stack gas (wet basis) equal to 400 ppm (v). Assume 50 percent removal efficiency with SNCR.	Based on review of data for several sources (see Ref. 3, 8, 9, 13, 16 in particular), emission testing conducted by LA/OMA using a MHF (Ref. 1), and consultant review (Ref. 2).
NO _x (sludge/refuse)	Uncontrolled 0.635 lb/ton of stack gas (wet basis) equal to 200 ppm (v). Assume 50 percent removal efficiency with SNCR.	Assumes that majority of NO _x is from fuel bound nitrogen (FBN) and that refuse contributes little FBN.
SO _x	0.221 lb/ton of stack gas (wet basis), equal to 50 ppm (v). Assumes FGD system.	Based on literature review (Ref. 3, 10, 16, 32, 36-41 in particular), emission testing conducted by LA/OMA (Ref. 1, 30), and consultant review (Ref. 2).
CO	0.0193 lb/ton of stack gas (wet basis), equal to 10 ppm (v).	Based on data supplied by manufacturer for gasification followed by an afterburner (Ref. 21, 25).
HC	0.011 lb/ton of stack gas (wet basis), equal to 10 ppm (v).	Based on data supplied by manufacturer for gasification followed by an afterburner (Ref. 21, 25).

- (a) JWPCP digester gas.
 (b) Hyperion digester gas.
 (c) OCSD digester gas.

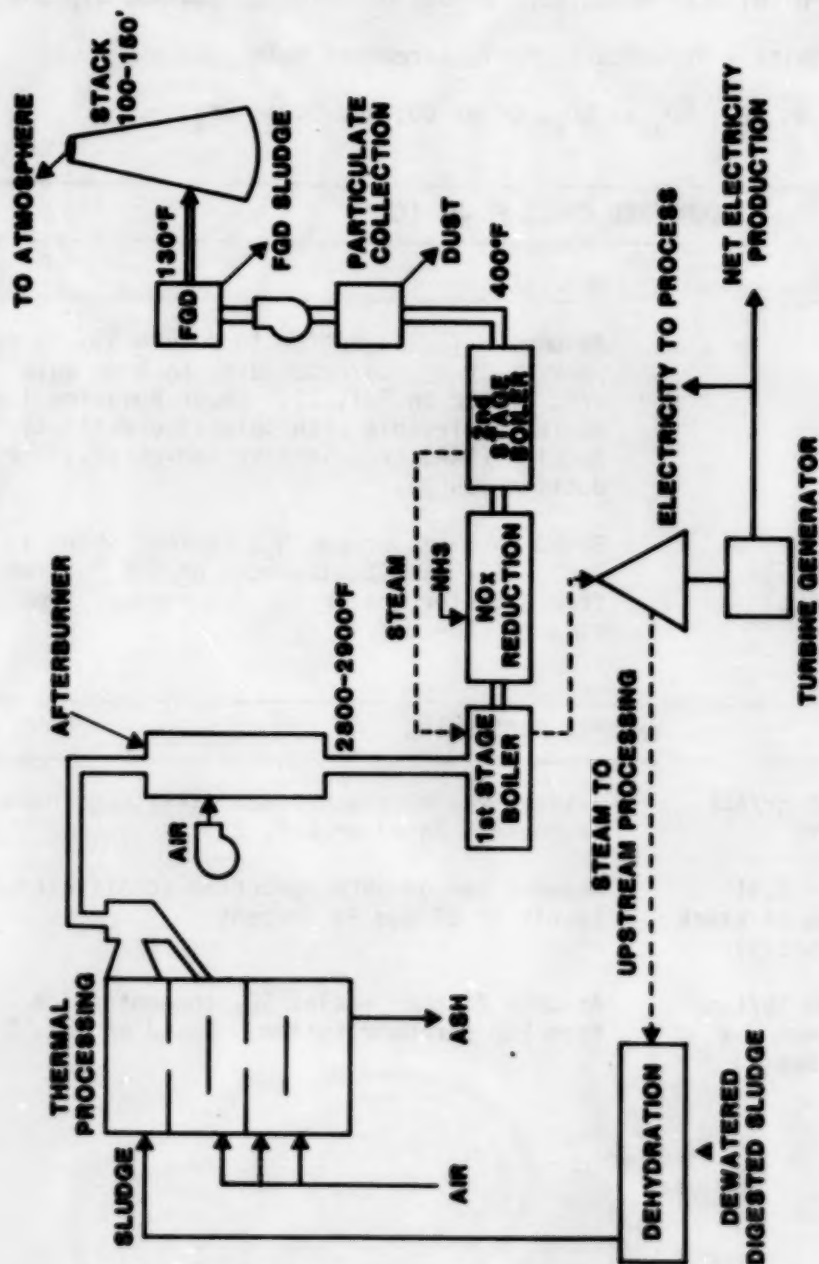
- Application of venturi scrubbers is not considered economical since achieving the specified particulate loading as well as efficient collection of sub-micron particles would require very high throat velocities and a pressure drop on the order of 50 inches water column.
- Wet scrubbing systems using lime, sodium hydroxide, or sodium carbonate can achieve significant reductions in SO_x emissions. An outlet flue gas concentration of 20 ppm (v) reportedly can be achieved from use of such controls on a thermal processing system. The emission factor shown in Table VII-5 for SO_x from thermal processing corresponds to a concentration of 50 ppm (v) in the flue gas.
- While several processes have been used for NO_x control, selective catalytic (SCR) and selective non-catalytic reduction (SNCR) processes using NH_3 injection appear to be the most developed. Catalysts have proven performance on clean fuels such as natural gas. Fuels which form significant quantities of particulate matter, however, present technical difficulties due to the potential for catalyst poisoning. Therefore, the selective non-catalytic system appears to be the most applicable to the thermal processing system.
- Selective non-catalytic NO_x reduction systems have reliably achieved 50 percent reduction in NO_x emissions. Potential exists for greater reductions in sludge processing applications that those achieved in current commercial applications. Such increased removal efficiencies on the order of 60 to 70 percent, could be achieved through (1) specific design of boiler systems to incorporate NO_x removal at the outset rather than retrofitting of boilers, and (2) steady state operation of the sludge processing system. Prospects for uniform operations are good due to the generally uniform characteristics of the dehydrated sludge and design provisions (e.g. offline storage) that could be incorporated to assure a uniform feed rate.
- Costs for the foregoing levels of control are not extraordinary when viewed in terms of total estimated costs of the proposed sludge management program.
 - Capital investment for emission controls on a system processing about 265 dry tons per day of sludge are about:
 - \$700,000 to \$900,000 for particulate emission controls
 - \$500,000 to \$1,500,000 for NO_x emission controls
 - \$1,300,000 to \$1,400,000 for SO_x controls
- Corresponding operating costs for the foregoing system are difficult to estimate but are indicated to be about:
 - \$75,000 for particulate emission control via conventional bag-house
 - \$150,000 for non-catalytic NO_x reduction systems
 - \$170,000 to \$250,000 for SO_x controls

- The foregoing cost ranges result from consideration of several control system types.
- Total annual cost (capital plus O & M) of emission systems for NO_x control (selective non-catalytic), particulate control (electrostatic baghouse to 0.0005 gr/ACF), and SO_x control (chemical scrubbing to 20 ppmv) represents about 8 percent of the projected total annual cost for dehydration and thermal processing.

It would appear from the foregoing that lower emission factors are achievable through application of innovative control technologies. However, since use of the emission factors given in Table VII-5 results in a conservative analysis, such factors are used in the analysis. The foregoing opportunities for emission reductions are considered to be potential mitigation measures should adverse impacts be identified and can serve as goals that should be pursued during detailed design of proposed facilities. Emission factors which may be achievable through application of innovative technologies are further discussed in Table VII-6.

A schematic process diagram of the dehydration, thermal processing (gasification), energy recovery, and air clean-up systems evaluated by the LA/OMA Project is shown in Figure VII-1. The dehydration, thermal processing and energy recovery portions of the system are discussed later in this chapter. In the proposed air emission control scheme, flue gas exits the afterburner and enters a gas-steam heat exchanger. Gas exits the first heat exchanger at about 1750°F and enters the non-catalytic NO_x reduction reactor where ammonia is injected. Following NO_x reduction, flue gas is cooled to 400°F or less in a gas-water heat exchanger. The limited temperature range of the NO_x reduction processes necessitated that the gas be cooled in two stages. Flue gas is then conducted (in the following order) through the particulate control device, induced draft blower, flue gas desulfurization system, and stack for final dispersal. Flue gas reheat prior to stack dispersal is not considered necessary at this time. The location of the blower was chosen to minimize blower surface erosion due to dust and to eliminate erosion and corrosion resulting from any aerosols exiting the sulfur scrubber.

The purpose of describing the control system of Figure VII-1 is to demonstrate that at least one control approach is available to achieve the emission factors described in Tables VII-5 and VII-6. Other control approaches to achieve comparable emission levels are not precluded as a result of the control system assumed for analysis. For example, SO_x emissions from combustion of solid fuels such as coal can be partially controlled by direct lime addition into the bed of a fluidized bed reactor (Figure VII-2). It should be noted that direct lime addition to a fluidized bed reactor has generally not demonstrated the high removal efficiencies necessary to achieve the emission factors of Tables VII-5 or VII-6, when combusting fuels containing 1 to 1.5 percent sulfur, which is typical of digested sludge. Therefore, a flue gas desulfurization system may be required even if direct lime addition were used. Pilot studies of lime addition to a fluidized bed reactor are to be performed by Los Angeles County Sanitation Districts using dehydrated sludge. Such studies should provide information regarding potential emissions from such system.



ENERGY RECOVERY USING GASIFICATION

FIG. VII-1

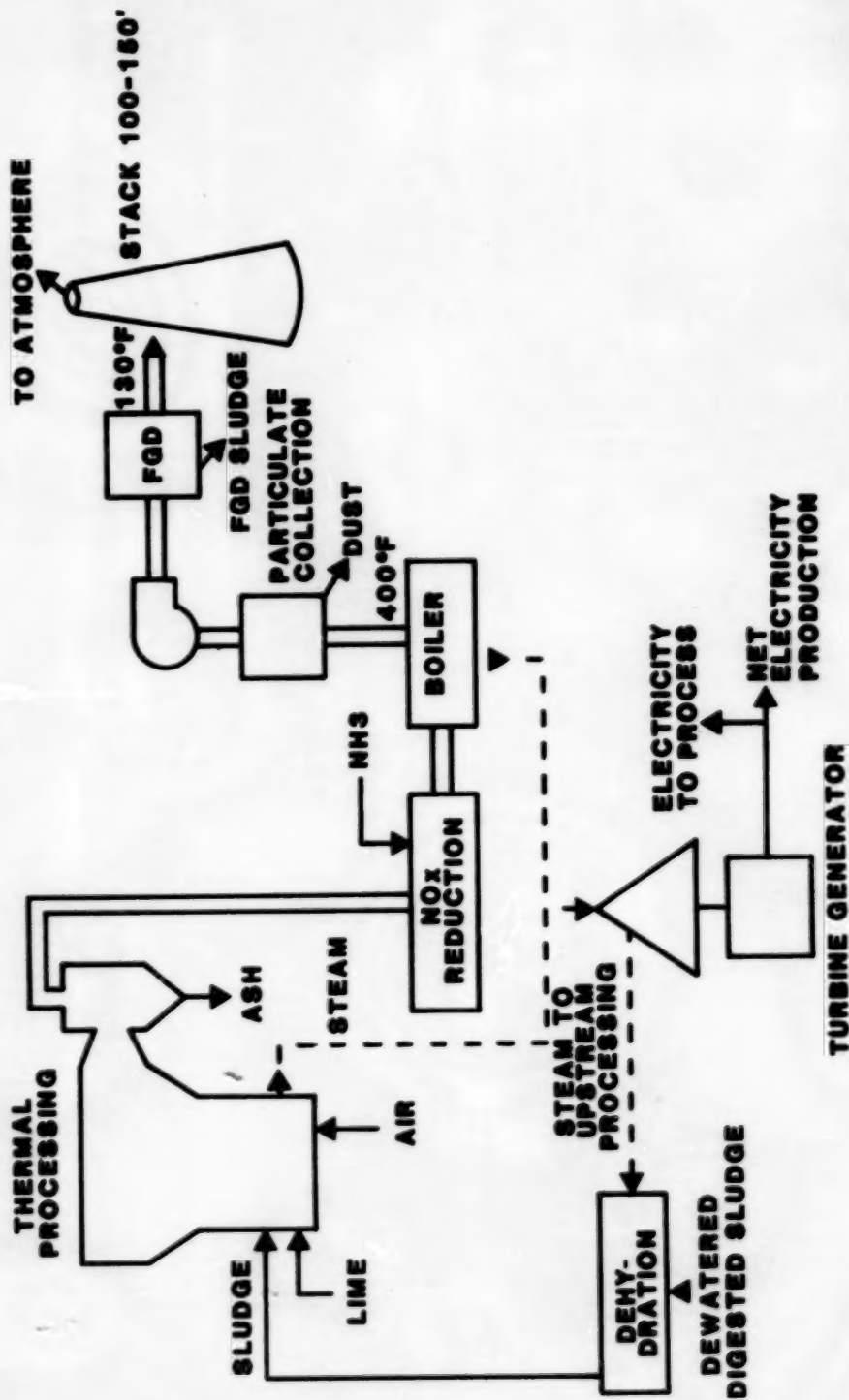
TABLE VII-6

EMISSION FACTORS POTENTIALLY ACHIEVABLE BY USE OF ADVANCED CONTROL SYSTEMS

(Units - lb/mmBtu of Fuel, Except as Noted)

NO_x as NO₂, SO_x as SO₂, CO as CO, and HC as CH₄

COMBINED CYCLE PLANT (CCP)		
Pollutant	FACTOR	REMARKS
NO _x	0.13	Assumes water injection to reduce NO _x to 80 ppmv at 3% O ₂ , corresponding to AQMD Rule 475. Based on Ref. 27. Lower emission levels may be achievable with selective catalytic reduction (SCR) or selective non-catalytic reduction (SNCR).
SO _x	0.0045(a) 0.0149(b) 0.0446(c)	Based on digester gas H ₂ S content shown in Table VII-5 and achievement of 90% H ₂ S removal from digester gas or 90% SO _x removal from exhaust flue gas.
THERMAL PROCESSING		
TSP	0.0005 gr/ACF @ 400°F	Assumes use of electrostatically augmented baghouse. Based on Ref. 2.
NO _x	0.38 - 0.51 lb/ton of stack (wet basis)	Assumes use of SNCR reduction at efficiency levels of 60 and 70 percent.
SO _x	0.0884 lb/ton of stack gas (wet basis)	Assumes 20 ppmv outlet SO _x concentration from FGD scrubber system. Based on Ref. 2.



**ENERGY RECOVERY USING A
FLUID BED COMBUSTOR**

FIG. VII-2

GENERAL SLUDGE HANDLING PROGRAM
LIFE AND ENVIRONMENTAL QUALITY IMPROVEMENT AREA

ENERGY RECOVERY SYSTEMS

An important feature of the sludge management plan is the recovery of energy from sludge organics. These organics are a renewable resource being derived ultimately from animal or vegetable sources. Because of the nonrenewable nature of fossil fuels, projected future shortages, and the increasing U.S. dependence on foreign oil, there is considerable interest in alternative, renewable energy sources.

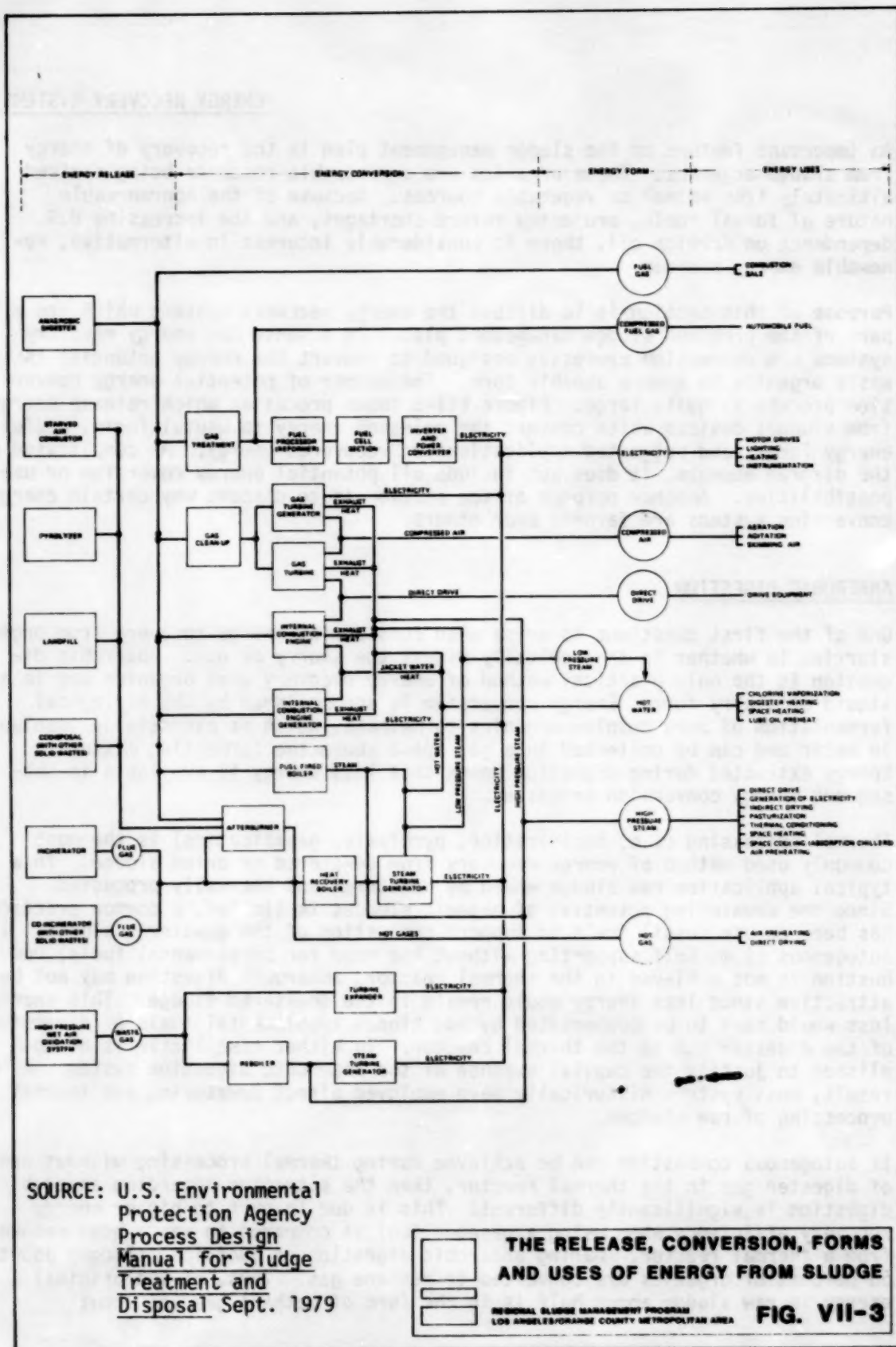
Purpose of this section is to discuss the energy recovery systems which are a part of the proposed sludge management plan. In a sense the energy recovery systems are conversion processes designed to convert the energy potential in waste organics to a more useable form. The number of potential energy conversion process is quite large. Figure VII-3 shows processes which release energy from sludge; devices which convert the released energy to useful forms, useful energy forms, and suggested applications of recovered energy. As complicated as the diagram appears, it does not include all potential energy conversion or use possibilities. Another purpose of the section is to discuss why certain energy conversion systems are favored over others.

ANAEROBIC DIGESTION

One of the first questions to arise when considering energy recovery from organic slurries is whether to anaerobically digest the slurry or not. Anaerobic digestion is the only practical method of energy recovery when organics are in a liquid or slurry form. Energy conversion is accomplished by the biological fermentation of more complex organics to methane, which is essentially insoluble in water and can be collected in a gas space above the fermenting mixture. Energy extracted during digestion means that less energy is available in subsequent energy conversion processes.

Thermal processing (i.e. incineration, pyrolysis, gasification) is the most commonly used method of energy recovery from dewatered or dried sludge. In a typical application raw sludge would be dewatered and thermally processed. Since the dewatering potential of organic sludges is limited, a common practice has been to use fossil fuels to support combustion of the dewatered sludge. If autogenous (i.e. self supporting without the need for supplemental fuels) combustion is not achieved in the thermal reactor, anaerobic digestion may not be attractive since less energy would remain in the dewatered sludge. This energy loss would have to be compensated by additional supplemental fuels or diversion of the digester gas to the thermal reactor. In either case little is accomplished to justify the capital expense of the anaerobic digestion system. As a result, most systems historically have employed direct dewatering and thermal processing of raw sludges.

If autogenous combustion can be achieved during thermal processing without use of digester gas in the thermal reactor, then the situation regarding anaerobic digestion is significantly different. This is due in part to higher energy recovery efficiency when using a gaseous fuel as compared to waste heat recovery from a thermal reactor. During anaerobic digestion of municipal sludges about 50 percent of organics are converted to methane gas. Thus, of the original energy in raw sludge about half is in the form of methane gas and about



SOURCE: U.S. Environmental
Protection Agency
Process Design
Manual for Sludge
Treatment and
Disposal Sept. 1979

half in the organics remaining in the digested slurry. The methane gas can be converted to electrical energy with an efficiency of about 30 percent. The electrical conversion efficiency from thermal processing of the remaining sludge organics is only about 5 to 10 percent. This difference in conversion efficiency is an advantage for anaerobic digestion in management systems designed for energy recovery from liquid organic slurries, provided autogenous combustion is achieved during subsequent thermal processing.

Anaerobic digestion accomplishes a number of other purposes which are of particular importance to the LA/OMA operating agencies. Principle among these are the stabilization of organics and reduction in odor potential compared to raw sludge. These factors are important in those portions of the management plan involving composting and reuse or landfill disposal. They are of some importance even when sludge is to be thermally processed since considerable processing and storage is required prior to the thermal reactor. Another function of the digestion system is to equalize the sludge load and sludge characteristics on downstream processes. This allows the thermal reactor to operate in a uniform, steady-state manner because of the homogeneous nature of the feed material. This can be a significant advantage since nonuniform operation can lead to temperature fluctuations and mechanical difficulties. Finally, the operating agencies have a long history of successful operation of anaerobic digesters and use of the produced digester gas. Both digestion and use of the digester gas are considered to be well proven and reliable technologies.

These factors combined with the large capital investment in existing digester systems were the basis for a decision of employ anaerobic digestion in all process flow trains within the alternative Sludge Management Projects. Anaerobic digestion will continue to play a major role in the proposed management program for the LA/OMA area. Many of the above factors will be discussed further in the following sections.

ENERGY RECOVERY FROM DIGESTER GAS

Use of the energy contained in digester gas can be accomplished in a number of ways including the following:

- On-site use in boilers and prime movers such as internal combustion (IC) engines or a combined cycle power generation system.
- Direct gas sale to utilities or industries in the vicinity of the treatment plant site.
- Cleanup of the gas to pipeline quality and injection into the natural gas supply system. Cleanup usually involves removal of water, carbon dioxide, and hydrogen sulfide from the digester gas.
- Conversion of the gas to a liquid fuel such as methanol and sale for off-site uses.

Decisions regarding on-site versus off-site uses are largely economic in nature. Historically, on-site use of at least a portion of the gas has been preferred due to the low sale price received from off-site users including public utilities. Analysis presented later in this chapter suggests that on-site users will

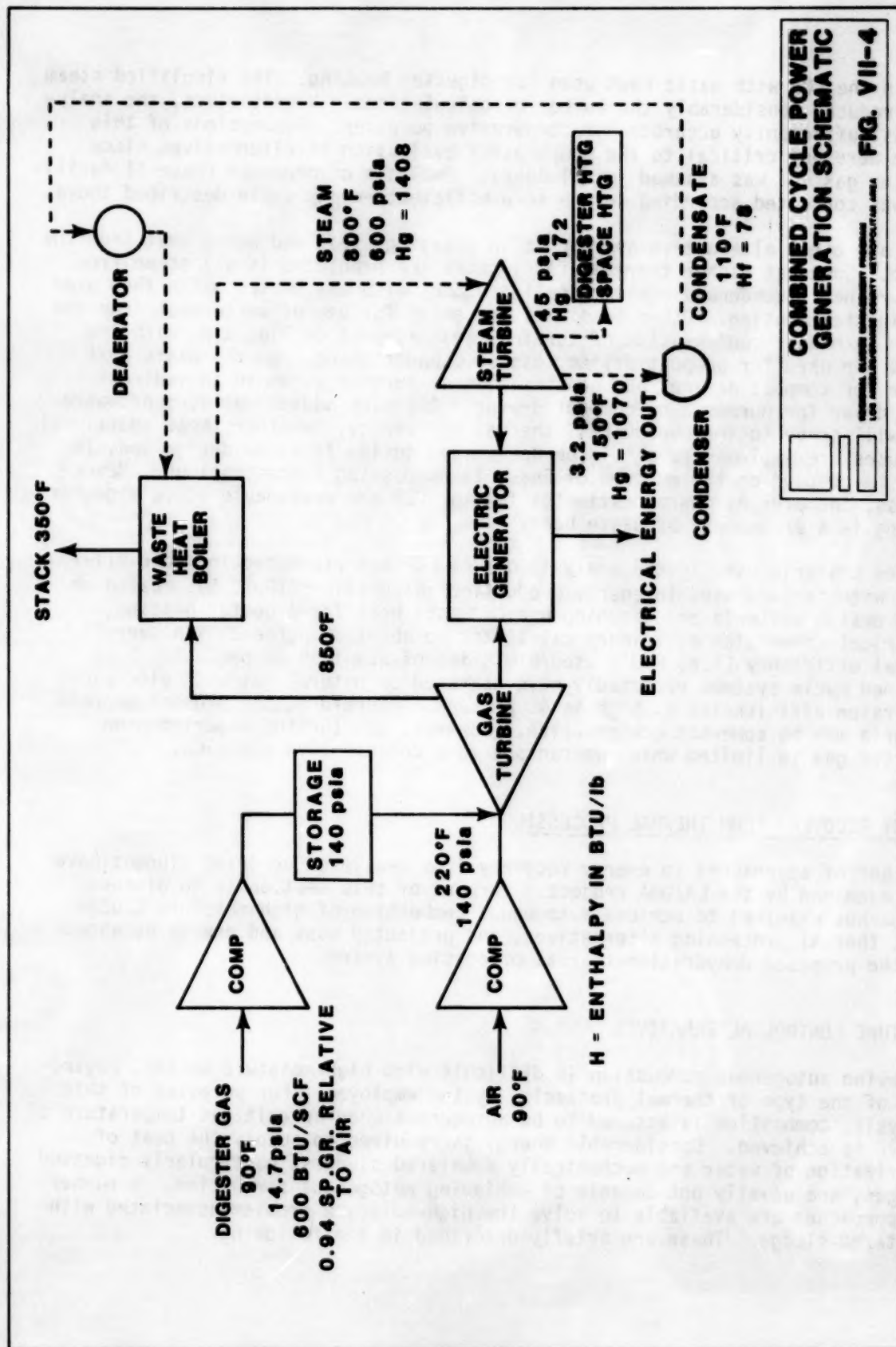
continue to be favored unless drastic increases in the sale price of digester gas or gas derived products are realized. There are indications that such increases may be realized due to present and projected supplies and cost of fossil fuels and recent changes in both State and Federal regulations regarding cogeneration projects. (Ref. 2,3)

The proposed management program for the LA/OMA operating agencies has assumed that digester gas would continue to be used on-site. In cases where dried sludge is to be thermally processed, emission offsets will be required in order for the thermal processing system to comply with new source review requirements. Complete or partial replacement of existing IC engine drives will be required to accomplish the required emission reductions. Analysis has indicated that IC engine drives and the CCP system have similar "gas to wire" efficiencies and comparable annual cost (Ref. 4). Therefore, when sludge is to be thermally processed, the proposed management plan has specified that digester gas be used on-site in a combined cycle power (CCP) generation facility which can accomplish reduced emission levels for TSP, NO_x , CO and HC compared to IC engines. The combination of digester gas use in the CCP system, retirement of IC engines, and application of innovative control systems is projected to provide sufficient offsets to meet new source review requirements. However, inclusion of the CCP system in the proposed management plan does not preclude other digester gas uses provided that (1) they can be shown to be cost-effective compared to on-site use in the CCP, and (2) they do not interfere with attainment of emission offsets required for the thermal processing system to comply with new source review. Further discussion will focus on digester gas use in the CCP system.

A combined cycle power generation system uses digester gas in a gas turbine (Brayton cycle) followed by a steam turbine (Rankine cycle) operated on waste heat from the gas turbine. About 75 percent of the fuel energy into a gas turbine exists with the high temperature exhaust. Capture and use of this energy by means of a boiler and steam turbine is an attractive method of improving overall thermal efficiency. A schematic of the CCP system is shown in Figure VII-4.

Digester gas is compressed to the combustion chamber pressure of the gas turbine (about 140 psia) and then stored temporarily until it is combusted in the turbine. The exhaust gas of the gas turbine is then passed through a boiler generating steam for the steam turbine. The turbines are connected to electric generators. Steam from the turbine is at low absolute pressure and must be condensed to a liquid before the fluid can be pumped to the boiler. Cooling water is commonly used to condense the exhaust steam. However, overall thermal efficiency can be improved if the heat of vaporization of condensing steam can be reused. In analysis of the proposed management plan it was assumed that a portion of steam would be extracted from the turbine at 45 psia and used for digester heating by indirect heat exchange. Condensed steam from the digester heat exchangers would be returned to the waste heat boiler. Remaining steam would be condensed against cooling water.

During analysis of the alternative Sludge Management Projects it was assumed that a portion of digester gas was directly used for steam production with the steam then used for digester heating. Remaining digester gas was then used in the CCP with all steam turbine exhaust condensed against cooling water. Such a cycle is less efficient thermally compared to the case where all digester gas is



**COMBINED CYCLE POWER
GENERATION SCHEMATIC**

GENERAL PLANT MAINTENANCE PROGRAM
LOS ANGELES COUNTY METROPOLITAN AREA

FIG. VII-4

used in the CCP with waste heat used for digester heating. The simplified steam cycle reduced considerably the number of calculations. Nevertheless, the analysis was sufficiently accurate for comparative purposes. Assumptions of this nature were not critical to the comparative evaluation of alternatives since digester gas use was assumed in all cases. Analysis of proposed Phase II facilities was conducted according to the more efficient energy cycle described above.

There are other alternative approaches to managing steam and waste heat from the system. Somewhat higher thermal efficiencies are predicted if all steam from the turbine is condensed against cooling water, with the heated water then used for digester heating. Other possibilities exist for use of waste heat from the system such as: condensation of turbine steam against cooling air, with the heated air used for compost drying; use of exhaust gases from the waste heat boiler for compost drying; and condensation of turbine steam in an indirect steam dryer for purposes of compost drying. All such additional uses of waste heat will serve to improve overall thermal efficiency. Whether these additional heat uses are implemented should be determined during facility design and, in part, may depend on the outcome of Phase II composting demonstrations. Nevertheless, the present energy estimates for the CCP are reasonable since digester heating is a proven use of waste heat.

Process criteria used in the analysis of the CCP are presented in Table VII-7 along with factors used in energy production calculations (Ref. 5). Based on these design criteria and assuming use of waste heat for digester heating, electrical conversion efficiency calculates to about 30 percent with overall thermal efficiency (i.e. BTU's used/BTU's in) of about 55-60 percent. Some combined cycle systems reportedly have operated on natural gas with electrical conversion efficiencies as high as 40 percent. Therefore, the present process criteria may be somewhat conservative. However, gas turbine experience on digester gas is limited which warrants a more conservative approach.

ENERGY RECOVERY FROM THERMAL PROCESSING

A number of approaches to energy recovery from dewatered or dried sludges have been examined by the LA/OMA Project. Purpose of this section is to discuss approaches examined to achieve autogenous combustion of high-moisture sludge cake, thermal processing alternatives, and projected mass and energy balances for the proposed dehydration-thermal processing system.

MOISTURE CONTROL ALTERNATIVES

Achieving autogenous combustion is difficult with high-moisture wastes, regardless of the type of thermal processing system employed. For purposes of this analysis, combustion is assumed to be autogenous when an exit gas temperature of 1400°F is achieved. Considerable energy is required to supply the heat of vaporization of water and mechanically dewatered sludges, particularly digested sludges, are usually not capable of achieving autogenous combustion. A number of approaches are available to solve the high-moisture problem associated with dewatered sludge. These are briefly described in the following.

TABLE VII-7

COMBINED CYCLE POWER GENERATION
CRITERIA FOR PROCESS EVALUATION

Digester Gas Characteristics

Composition	60% CH ₄ , 40% CO ₂
Heat Value	600 Btu/SCF
Moisture	Saturated @ 14.7 psi and 90°F
Specific Gravity	0.94
R (Gas Constant)	71.88 $\frac{\text{ft-lbs}}{\text{lb}_m - \text{OR}}$

Gas Turbine - Generator

Efficiency	25% (Electric Power Out/Btu's of Fuel In)
Exhaust Gas Temp	850°F
Exhaust Flow	46 lbs/hr per kW

Steam Turbine

Stack Temp	350°F
Condenser Temp	110°F
Steam	600 psia @ 800°F
Specific Heat of Exhaust Gas	0.25 $\frac{\text{Btu}}{\text{lb} - \text{OF}}$
Turbine Efficiency	78% (overall)

Energy Production Calculations

Work to compress gas to 140 psia

$$\text{Work (ft-lbs/SCF)} = 0.075 \text{ lbs/ft}^3 \times 0.94 \times 71.88 \frac{\text{ft-lbs}}{\text{lb}_m - \text{OR}} \times 550 \text{ OR} \times \ln(140 \text{ psia}/14.7 \text{ psia}) / .75(\text{efficiency})$$

Power required to compress gas

$$\text{Power (kW)} = \text{gas flow (SCF/hr)} \times \frac{\text{work (ft-lb/SCF)}}{2,655,260 \frac{\text{ft-lb}}{\text{kW-hr}}}$$

Gas turbine output

$$\text{Power} = \frac{(\text{digester gas flow Btu/hr}) \times 0.25}{3413 \frac{\text{Btu/hr}}{\text{kW}}}$$

Steam turbine output

$$\begin{aligned} \text{Power} &= (\text{gas turbine output kW}) \times 46 \frac{\text{lbs/hr}}{\text{kW}} \times (850^\circ\text{F} - 350^\circ\text{F}) \\ &\times 0.25 \frac{\text{Btu}}{\text{lb} - \text{OF}} \times (1408 - 975) \frac{\text{Btu}}{\text{lb steam}} \times .78 / ((1408 \frac{\text{Btu}}{\text{lb steam}} - 78 \frac{\text{Btu}}{\text{lb steam}})) \\ &\times 3413 \frac{\text{Btu/hr}}{\text{kW}} \end{aligned}$$

Net power = gas turbine - compressive power + steam turbine

- Add Auxiliary Fossil Fuels

The addition of natural gas or fuel oil to support sludge combustion has been historically the most popular approach to overcome high-moisture limitations. However, the high cost of fuels and the nation's dependence on foreign energy sources has caused this approach to fall into disfavor. Use of fossil fuels in this manner was considered inappropriate in light of national goals to reduce energy dependence and, therefore, was not seriously pursued except for comparative purposes.

- Add Alternative Fuels

Alternative energy sources such as refuse derived fuel (RDF) and agricultural wastes can be used in place of fossil fuels to support combustion of dewatered sludges. Both of these approaches were examined by LA/OMA. Agricultural wastes such as manure were found to be in limited supply in the LA/OMA area and would not entirely support autogenous combustion of dewatered sludge. The potential supply of refuse is not limited, however, and RDF is an acceptable fuel substitute. Large quantities of RDF would be required to achieve autogenous combustion, about 1.2 lb RDF/dry lb of digested sludge combusted at 25 percent solids. Considering the efficiency of producing RDF from refuse and assuming the refuse facility to be open 5 day/week, a ratio of about 2.2 lb refuse as received (5 day basis) would be required per lb dry sludge. Any commitment to use of refuse must recognize the relatively large quantities required. Energy recovery from sludge and solid waste was judged to have improved prospects for implementation at a future date for reasons discussed in Chapter IV.

- Increase Cake Solids

Autogenous combustion can be achieved without the use of supplemental fuels if high cake solids content can be achieved during dewatering. Alternative sludge conditioning and alternative dewatering devices were examined as possible methods of improving cake solids. Thermal conditioning followed by belt press or filter press dewatering was found to produce autogenous sludge cake. Steam production from thermal processing of dewatered cake was projected to be greater than the steam requirements for thermal conditioning. However, concerns for odor and mechanical complexity could not be sufficiently resolved and this approach was eventually deferred in favor of energy efficient dehydration technology.

- Combust Raw Rather Than Digested Sludge

Approach was examined but later deferred for reasons discussed previously.

- Energy Efficient Dehydration Prior To Thermal Processing

A number of processes have been developed to separate water from solids with less energy input compared to conventional heat drying systems.

The Carver-Greenfield (CG) process, a proprietary multiple-effect system, has been developed for drying of slurries and suspensions of solid materials. The CG process has been demonstrated in large municipal and industrial facilities and is a viable process for the LA/OMA operating agencies. A four-effect Carver-Greenfield system can evaporate water with a thermal input of about 400-600 BTU/lb water evaporated, compared to a conventional drying or thermal processing system with a thermal requirement of about 1500-2000 BTU/lb. Carver-Greenfield drying of combined sludge will produce a material capable of autogenous combustion without the need for supplemental fuels. Multiple-effect drying and thermal processing is a net energy producing system. Sufficient steam can be provided during thermal processing for net electrical power production as well as operation of the drying process.

Energy efficient drying and thermal processing are major elements of the proposed sludge management program for the LA/OMA area. Further discussion will center on use of this approach for energy recovery from digested sludge organics.

ENERGY EFFICIENT DEHYDRATION

The key to energy recovery from high-moisture organics, without use of supplemental fuels, is the energy efficient removal of water prior to combustion. Water added to a thermal reactor exerts a considerable demand on the available energy sources. For example, under conditions of a 20 percent sludge cake, 40 percent excess air ratio and 1400°F exhaust temperature, energy requirements to heat and evaporate water can account for over 70 percent of the total energy requirements in the thermal processing systems. Most of this energy is required to satisfy the high heat of vaporization of water, which cannot be recovered in subsequent waste heat recovery systems.

Water added to a thermal reactor must be heated to boiling, vaporized, and then the vapor heated to the exit gas temperature from the reactor. Assuming an inlet water temperature of 80°F and exit gas temperature of 1400°F, about 1400 BTU/lb of water added to the reactor is required. More energy efficient removal of water prior to combustion means (1) that less energy is required to vaporize and heat the water and (2) energy recovery potential during subsequent thermal processing is increased because higher exit gas temperatures can be achieved. Thus, the combination of energy-efficient dehydration followed by thermal processing is a particularly attractive combination of processes for energy recovery from high-moisture organics.

As mentioned previously, a number of processes have been developed to separate water from solids with less energy input compared to conventional heat drying systems. In most cases these processes have been developed for desalination of high TDS (total dissolved solids) water. As such, they would not be applicable to slurries or suspensions containing solids. However, at least one dehydration process has been developed with specific applications to solid suspensions. The Carver-Greenfield process (patented by Dehydrotech Corporation, formerly Carver-Greenfield Corporation) has been applied to various organic and inorganic industrial slurries as well as industrial and municipal wastewater sludges.

In the Carver-Greenfield system, water is extracted from sludge by evaporation using a multi-effect evaporator. Sludge to be processed is first thickened or dewatered as much as possible to reduce the amount of water to be evaporated. Dewatered sludge is then mixed with an oil (carrying medium), such as Isopar L. By use of an oil, fluidity is maintained in all effects of the evaporation cycle and formation of scale or corrosion of the heat exchangers is minimized. The sludge-oil slurry is then pumped to the multi-effect evaporator where water is vaporized. The remaining solids-oil mixture is subsequently centrifuged and hydroextracted to separate the oil and solids. The oil is recycled and reused while the solids are discharged for further processing or disposal.

Multi-effect evaporation affords an economy of steam over single-effect operations through the reuse of heat. The Carver-Greenfield process employs reverse flow, multi-effect evaporation with steam being added to the last effect. For example, in a three effect system, vapor from the last effect is used to provide heat in the second effect and the vapor from the second furnishes heat to the first. Vapor from the first effect is removed, condensed and discharged. Through the reuse of heat in the multiple-effect process, the amount of water removed per pound of steam supplied increases with increasing number of effects.

In its simplest theoretical form, a single-effect evaporator can evaporate a maximum of one pound of water per pound of steam supplied. A two effect evaporator will evaporate two pounds of water per pound of steam supplied, because of the reuse of heat. Depending on the number of effects used, the amount of heat energy required per pound of water removed will vary. For a single-effect unit, at least 1000 BTU per pound of water removed is required and for a double-effect unit, at least 500 BTU is required per pound of water removed, etc. Vacuum is applied to the various effects to produce a temperature difference between effects and thus allow heat transfer between effects.

It would appear that an infinite economy of steam would result from the use of an infinite number of effects. Several factors, however, limit the number of effects practicable in a system. Each effect of a multiple-effect evaporator operates only on a fraction of the total temperature drop across the system. The total drop is seldom larger than that employed in a single-effect evaporation, and the capacity per unit area of heating surface is reduced proportionately. Thus, a savings in fuel requirements may be realized through multiple-effect operation but equipment costs will be greater. In most cases, no more than three or four effects are economical but the actual number is largely influenced by prevailing fuel and equipment costs.

It should be noted that other energy efficient dehydration systems may be available for removal of water from solid suspensions. Use of such systems would not be precluded by specific mention of the Carver-Greenfield process in this discussion. However, the Carver-Greenfield process is well developed with existing installations processing sludges similar to those produced by the LA/OMA operating agencies.

Field demonstrations and engineering studies of the Carver-Greenfield process were undertaken to the LA/OMA Project to determine the applicability of the

process to the sludge management situation in the LA/OMA area (Ref. 6). Major conclusions of these studies are outlined as follows.

- The Carver-Greenfield system appears to be a viable sludge drying process and offers considerable energy efficiency compared to conventional direct or indirect contact dryers.
- Technology involved in the Carver-Greenfield process is not beyond that which can reasonably be expected to be operated in moderate to large treatment plants.
- Energy requirement for a four-effect Carver-Greenfield system with hydro-extraction is projected to be about 0.44 lb of steam per lb. H₂O evaporated. This value is based on data supplied by the manufacturer, operating experience of existing facilities, and supported by theoretical analysis of the system. Assuming a boiler efficiency of 80 percent, and an enthalpy change of 1000 BTU/lb for 65 psia saturated steam, the energy requirement including steam production would be about 550 BTU/lb H₂O evaporated.
- Even though the C-G system is energy efficient compared to conventional dryers, energy requirements can still be significant. Therefore, mechanical dewatering prior to the Carver-Greenfield is advisable to reduce the evaporative burden.
- Oxygen demand, imposed on secondary treatment facilities from recycle of the process condensate, is projected to average less than 1 to 2 percent of that exerted by the primary effluent flow in the case of dehydration of dewatered sludge. No other constituents which would likely impact operation of the treatment plant were found in the condensate. However, the effect of ammonia should be considered on processes such as nitrification and breakpoint chlorination. It is concluded that the process condensate could be directly recycled without producing significant impact on the treatment plant.
- Additional fluidizing oil recovery, beyond that achieved by centrifugal dewatering, is essential to make the process economically viable and reduce dependence on outside sources of fluidizing oil. Hydroextraction of the centrifuged oil-solids mixture was shown to be effective in recovery of the remaining oil. Fluidizing oil losses in the hydroextracted product was about 1.0 percent or less of the infeed solids by weight.

Subsequent analysis by other investigators (Ref. 7) yielded essentially the same conclusion that the Carver-Greenfield is a viable, technically sound sludge drying process.

THERMAL PROCESSING ALTERNATIVES

A number of approaches to thermal processing and energy recovery from dewatered or dehydrated sludge were evaluated by the LA/OMA Project. Systems examined can be broadly classified as follows:

- Incineration - Complete oxidation of feed organics using greater than stoichiometric quantities of oxygen.

- Gasification - Partial oxidation of feed organics using sub-stoichiometric oxygen quantities to produce a fuel gas. Also, referred to as starved air combustion or partial pyrolysis.
- Pyrolysis - Thermal decomposition in the absence of oxygen.

A pyrolysis reactor was field tested by the LA/OMA Project in conjunction with the Los Angeles County Sanitation Districts. The system was designed to produce both gaseous and liquid fuel products in an indirect fired reactor under pyrolysis (no oxygen) conditions. The potential advantage of producing liquid or gaseous fuels is that they can be stored, transported, and used in efficient energy recovery cycles. Gaseous fuels can also be cleaned prior to combustion which may be less expensive than subsequent flue gas cleanup. While both gaseous and liquid fuels were produced during the field tests, significant mechanical difficulties were encountered during cooling and condensation of fuels along with odors and high strength liquid sidestreams. The indirect fired nature of the reactor also resulted in significant heat transfer limitations (Ref. 8,9).

Based on this experience, a decision was made to limit further investigations to direct fired reactors which are not as prone to heat transfer limitations. Production of storable fuels was also judged to be in the developmental stage and may not be appropriate technology for a municipal treatment plant at this time. Also, production of storable fuels may not be an advantage in large municipal treatment facilities where demand for power is relatively constant. Further efforts were focused on direct fired thermal reactors and more proven energy recovery cycles.

Dehydrated, pelleted sludge was test burned in a vertical shaft gasification test furnace and a rotary hearth test furnace. Partial slagging and fusion of the pelleted, dried sludge was observed during gasification tests at 1850°F in a vertical shaft furnace. Reducing the temperature to 1500°F reduced but did not eliminate the problem of fusion. The pelleted sludge was successfully gasified in a small-scale rotary hearth furnace with no slagging or other material handling problems observed. (Ref. 6)

Based upon the successful operation of the hearth reactor, the established performance of multiple hearth furnaces (MHF) in municipal sludge practice, and recent full scale tests of MHF technology applied to gasification of refuse and sludge mixtures (Ref. 10), a decision was made to assume use of a MHF operated in a gasification mode for purposes of economic and engineering analysis. It was not the intention to preclude other reactor types by using the MHF for evaluation purposes. Indeed, fluidized bed reactors (FBR) and suspension fired boilers (SFB) appear to be applicable to combustion of dehydrated sludges as may other reactor types. It should be noted, however, that combustion of dehydrated sludge, because of the low moisture content, will result in high reactor temperatures unless provisions are taken to control the energy balance. For the MHF, this means that the reactor must be operated in a gasification mode (i.e. starved air) to limit the heat output rate in the furnace. A fuel gas is produced from the partial oxidation and is subsequently combusted in an afterburner. FBR reactors have also been operated in a gasification mode but the technology is not as well developed as with the MHF. Most FBR systems being developed for coal combustion are operated in an incineration mode, with steam tubes placed in the fluidized bed to extract excess heat and maintain bed temperatures below the

point where slagging occurs. Los Angeles County Sanitation Districts are to conduct pilot studies of the FBR system using dehydrated sludge.

Due to concern over temperature control and the lack of design criteria specific to combustion of low moisture fuels, pilot scale gasification tests using dehydrated sludge were conducted (Ref. 11). Objectives of the study were to demonstrate the feasibility of gasification of dehydrated sludge in a MHF, develop mass and energy balance relationships, loading factors, and air emission factors. The MHF operated in a stable and predictable manner during gasification of dehydrated sludges at temperatures up to 1700°F without evidence of slagging. Hearth loadings between 8-14 lb/hr-ft² were achieved in the study. Air emission data were also collected which played a significant role in the development of air emission factors and control systems described previously.

A significant finding of the pilot gasification studies was that hearth loadings of about 10 lb/hr-ft² could be maintained even with dehydrated sludge. A similar hearth loading was assumed for thermal processing of dewatered sludge and dewatered sludge/refuse mixtures. This is of considerable economic significance since the size of the thermal processing system becomes a function of the total daily wet weight of feed material. Thus, prior removal of water by dehydration reduces the size and cost of subsequent thermal processing. For example, the hearth area required to process dewatered cake at 25% solids (with supplemental fossil fuels used to achieve autogenous combustion) would be about 4 times that required if the sludge is first dehydrated. Similarly, if RDF is used as supplemental fuel and added to dewatered cake at 25% solids to achieve an autogenous mixture, hearth area would be about 5 times that required for combustion of the dehydrated sludge alone.

Major reductions in the size of the thermal processing system can be achieved compared to combustion of dewatered cake or dewatered cake/refuse mixtures. Cost savings realized in the thermal processing system can offset the cost of dehydration (Ref. 12).

The following thermal processing alternatives were studied as part of the analysis of sludge management alternatives. (SMA 3 - Thermal Processing, see Appendix C for detailed process diagrams.)

- Permutation A - Codisposal: Mechanical dewatering and thermal processing with various levels of refuse addition.
 - MHF reactor, fuel oil used to achieve autogenous combustion
 - MHF reactor, RDF used as a supplemental fuel, various rates of RDF/sludge were examined.
 - Purox converter, refuse used as a supplemental fuel, various ratios of refuse/sludge were examined.
- Permutation B - Thermal Conditioning: Thermal conditioning, mechanical dewatering, thermal processing in a MHF. No refuse addition. Separate thermal conditioning of WAS only also considered.
- Permutation C - Dehydration: Mechanical dewatering, Carver-Greenfield

dehydration, thermal processing in a MJF. No refuse addition. Separate Carver-Greenfield dehydration of WAS only also considered.

Projected system costs for Carver-Greenfield dehydration/thermal processing were less than all other thermal processing permutations studied. Furthermore, dehydration/thermal processing resulted in nearly equivalent net energy production compared to codisposal options, and greater net energy compared to thermal conditioning options. (Ref. 12).

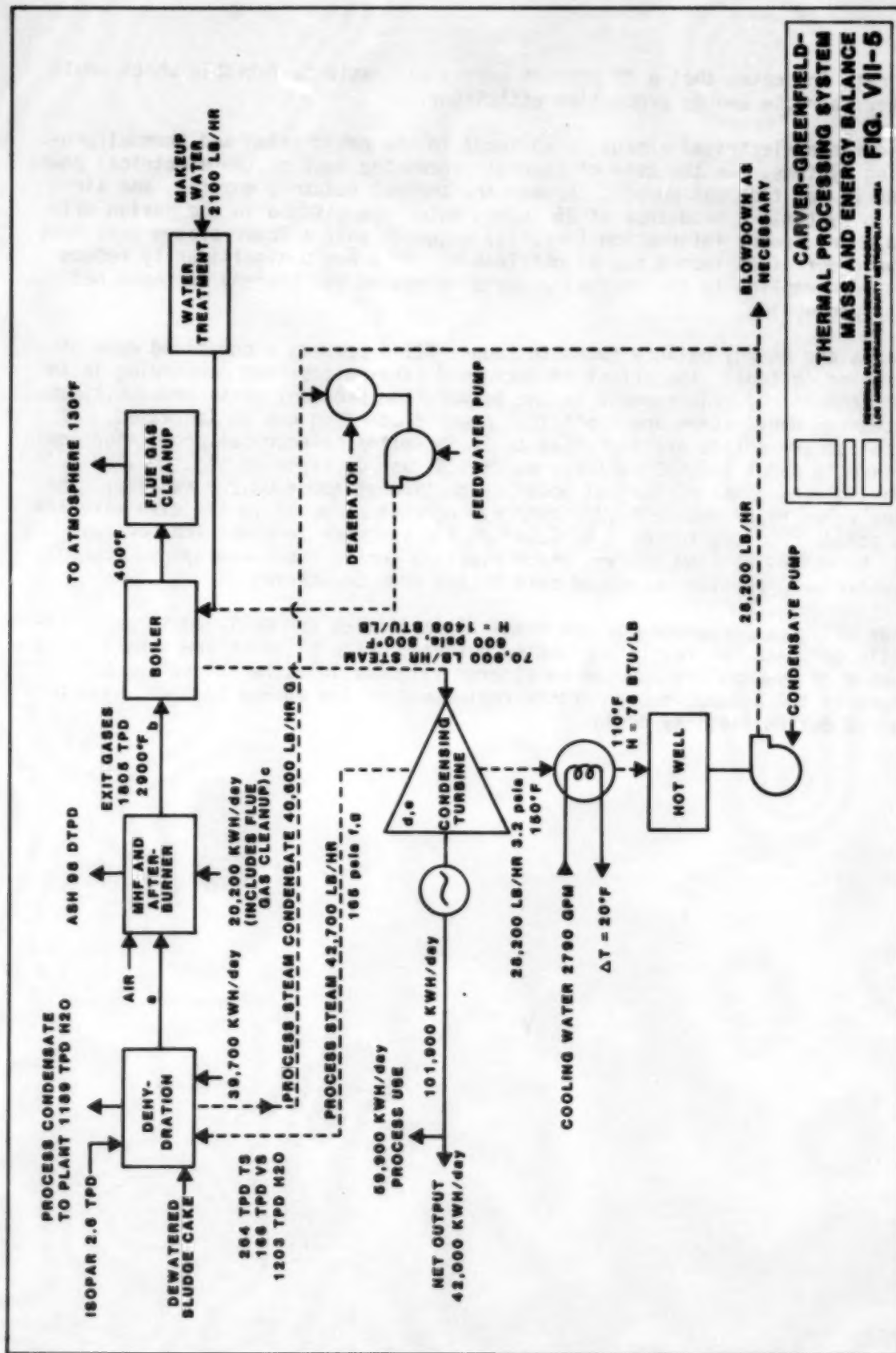
MASS AND ENERGY BALANCES

A mass and energy balance for the combined system of dehydration-thermal processing-energy recovery is shown in Figure VII-5. The particular balance is for the CLA Phase II conditions.

In developing the mass and energy balance it was assumed that any extracted heavy oil from the CG process is combined with dry product solids and gasified in the multiple hearth furnace. Low BTU fuel gas produced under gasification conditions in the multiple hearth would be immediately afterburned and passed through a boiler for steam production. The mass flow and temperature of flue gases exiting the afterburner were calculated from a heat and mass balance considering the infeed fuel content and 40 percent excess air supply. Steam production was calculated assuming an exit gas temperature from the boiler of 400°F. Electrical production is by condensing steam turbine with an extraction of process steam for the CG unit at 165 psia. Other power systems have been proposed including direct combustion of the fuel gas in a combined cycle system. The latter would be electrically more efficient than the steam shown in Figure VII-4. However, it has not yet been demonstrated in full scale practice with the low BTU gases produced in a multiple hearth furnace. Therefore, the more proven, but perhaps less efficient system shown in Figure VII-5 was assumed for purposes of analysis.

It was assumed that all volatile solids are oxidized or gasified in the thermal reactor. Thus, solids output from the reactor consists only of the ash fraction of the infeed sludge. In actual practice, a portion of the feed volatiles are more resistant to combustion. This fraction, usually termed the fixed carbon content, may comprise 20 to 25 percent of total feed combustibles and will not usually be completely oxidized or gasified in a multiple hearth furnace. During LA/OMA sponsored pilot gasification studies on a multiple hearth furnace (Ref. 11), about 18 percent of the input heat of combustion was present as fixed carbon in the char/ash output stream. Projections to a commercial size furnace suggest that this can be reduced to about 12 percent of input heat of combustion with improved control of air injection and other operating conditions. Energy production from the thermal processing system would be reduced in approximate proportion to the reduction in organics oxidized or gasified in the furnace. Thus, if 12 percent of input heat of combustion is present in char/ash, a reduction in energy output on the order of 12 percent should be expected.

On the other hand, changes in other design criteria may serve to increase energy production over projections shown in Figure VII-5. Exit gas temperature from the waste heat boiler was assumed to be 400°F. Lower exit temperature may be practicable and would improve the energy recovery efficiency. An excess air ratio of 40 percent (1.4 times stoichiometric) was assumed in the analysis.



**CARVER-GREENFIELD-
THERMAL PROCESSING SYSTEM
MASS AND ENERGY BALANCE
FIG. VII-5**

THERMAL GLASS MANAGEMENT PROGRAM
LOS ANGELES COUNTY METROPOLITAN AREA

Test data indicates that a 25 percent excess air ratio is feasible which would further increase energy production efficiency.

Considerable electrical energy is consumed in the dehydration and thermal processing systems. In the case of thermal processing most of the electrical power demand is for flue gas pumping through the thermal reactor, ducting, and air cleanup system. A head loss of 25 inches water was assumed in the design criteria. More recent information (Ref. 13) suggests that a lower system head loss on the order of 15 inches may be obtainable. This would significantly reduce energy consumption in the thermal processing system and thereby increase net energy production.

The mass and energy balance shown in Figure VII-5 assumes a dewatered cake of 18% solids content. The effect of increased cake solids from dewatering is to reduce the energy requirements in the dehydration process. Less process steam is used for dehydration and electrical power production can be increased. If dewatered cake solids are increased to 22.5% solids, electrical production would increase to about 118,500 KWH/day, electrical use decrease to about 50,300 KW/day, giving a net electrical power production of about 68,200 KWH/day. The latter value represents a 26,200 KWH/day increase compared to the case with 18% cake solids from dewatering. At \$.04/KWH the increase in electrical energy would be valued at \$380,000/yr, which places a considerable energy and economic incentive on producing increased cake solids from dewatering.

Energy balances presented for the Phase II facilities are believed to be sufficiently accurate for facility planning purposes. The balances are sensitive to a number of assumptions and can be altered slightly in either direction by changes in the assumptions. Further refinement of the energy balances will be required during facility design.

**SELECTED TOPICS ON
COST EFFECTIVENESS**

SELECTED TOPICS FOR COST-EFFECTIVENESS

There are a number of issues relating to cost effectiveness which were not fully discussed in the previous Phase II facility descriptions. Purpose of this section is to discuss these topics since they are applicable to each operating agency.

ON-SITE VS. OFF-SITE POWER GENERATION

In development of the Phase II facility descriptions it was assumed that digester gas would be used on-site to meet power demands from sludge and wastewater processing. This assumption was based on the following economic analysis comparing on-site with off-site use (i.e. direct sale of digester gas). Off-site use by direct sale may be applicable for the LA/OMA agencies due to the proximity of large energy users. Only off-site use from digester gas sale was considered in the analysis. Sale of steam produced from thermal processing was not considered because the temperature and pressure conditions of the steam differ from those generally desired by steam electric utilities.

Economic and energy production values for the Hyperion treatment plant were used in the analysis. However, conditions are sufficiently similar that results can be applied to other LA/OMA agencies. The following values were taken from computer analysis of Project 3S1 for Hyperion under condition of partial secondary treatment.

Total Digester gas production	2891×10^6 BTU/Day
Net digester gas production	2182×10^6 BTU/Day
Total power output from a combined cycle plant operating on the net gas production.	217×10^3 BTU/Day

The cost of purchasing 217,000 KWH/day is given in Table VII-8 for various unit cost factors. Costs shown in Table VII-8 represent the value of electricity produced on-site.

While considerable value can be assigned to electrical energy, the cost of producing 217,000 KWH/day must also be considered. Costs of on-site power generation by a combined cycle system were taken from the computer analysis of Project 3S1 at Hyperion (marine secondary) and summarized in Table VII-9.

Under the project assumptions the cost of on-site power generation from digester gas is about 1.2 ¢/KWH. The cost includes service charges for standby power from the utility company. Potential revenue from sale of the net digester gas production is presented in Table VII-10 for various unit cost factors.

Using data from Tables VII-8 and VII-9, the value of purchased electrical power required to yield an equivalent revenue from the sale of digester gas can be determined. The relationship between purchased power cost and digester gas revenue is shown in Figure VII-6. It is interesting to note that purchase of electrical power at \$.04/KWH represents a nearly equivalent value as sale of digester gas at \$4/mmBTU. This same relationship holds over the range of values considered, due primarily to the fact that efficiency of electrical power generation is about 10,000 BTU/KWH.

TABLE VII-8
COST OF PURCHASED POWER

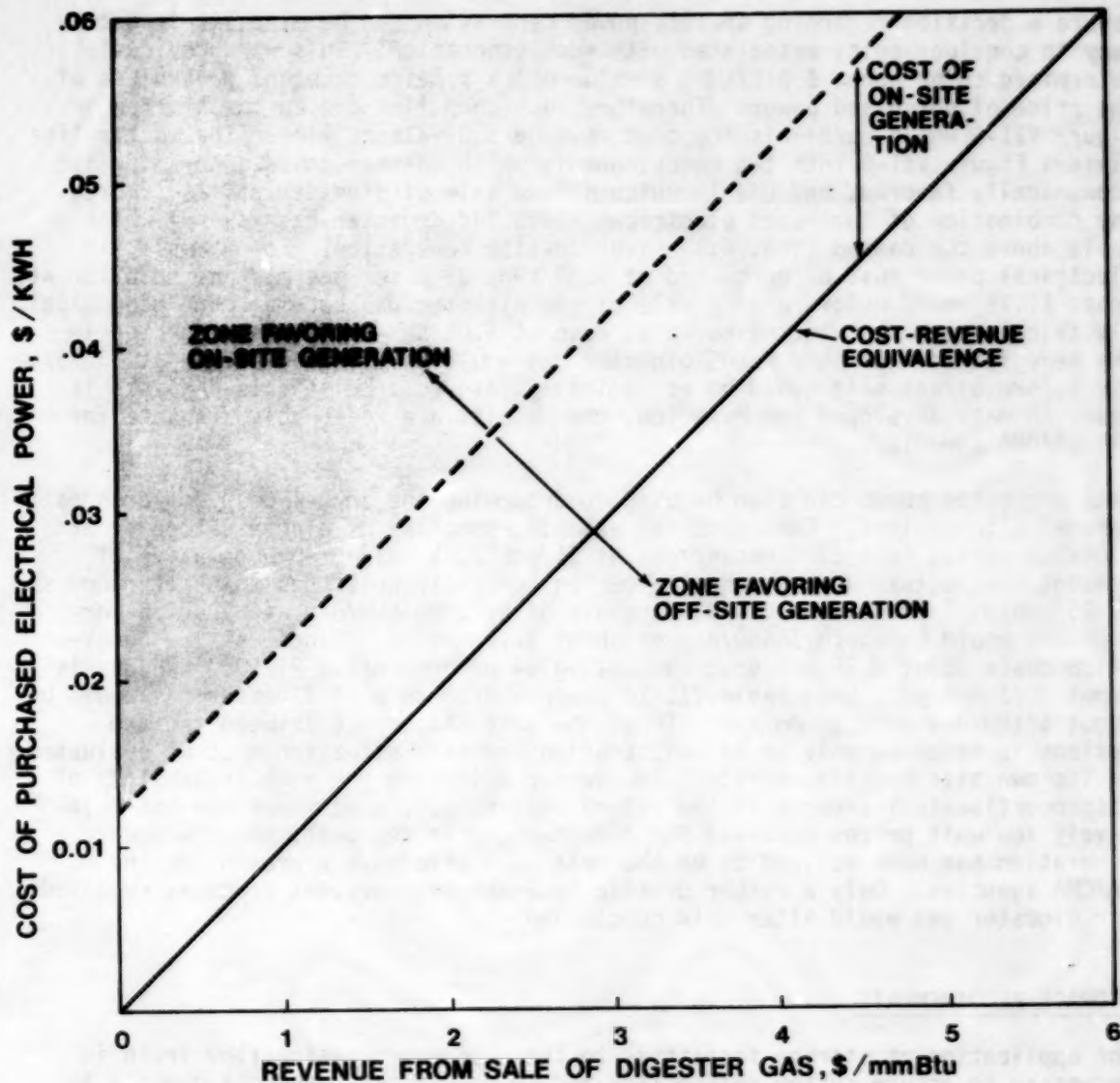
UNIT COST \$/KWH	TOTAL COST \$1000/DAY
.03	6.51
.04	8.68
.05	10.85
.06	13.02
.07	15.19
.08	17.36
.09	19.53
.10	21.70

TABLE VII-9
COST OF ON-SITE POWER GENERATION BY COMBINED CYCLE POWER SYSTEM

Annual Capital Cost	\$354,000
Annual O & M Cost - Labor	390,000
- Maintenance	106,000
Service Charge for standby power from DWP @ \$1/KW/month for 9000 KW	108,000
TOTAL ANNUAL COST	\$958,000
Generation Cost = $958,000 / (217 \times 10^3 \times 365)$	
=	\$.012/KWH

TABLE VII-10
REVENUE FROM THE SALE OF DIGESTER GAS

UNIT PRICE \$/10 ⁶ BTU	TOTAL REVENUE \$1000/DAY
1	2.18
2	4.36
3	6.55
4	8.73
5	10.91
6	13.09
7	15.27
8	17.46
9	19.64
10	21.82



ECONOMIC ANALYSIS OF ON-SITE VS OFF-SITE POWER GENERATION

REGIONAL SLUDGE MANAGEMENT PROGRAM
LOS ANGELES-ORANGE COUNTY METROPOLITAN AREA

FIG. VII-6

Before a decision regarding on-site power generation can be made, it is necessary to consider costs associated with such generation. This was previously determined to be about \$.012/KWH, a value which remains constant regardless of the price of purchased power. Therefore, a second line can be constructed in Figure VII-6 which parallels the cost revenue equivalence line. The latter line divides Figure VII-6 into two zones; one in which on-site power generation is economically favored, and one in which direct sale of digester gas is favored. Any combination of purchased electrical costs and digester gas revenue which falls above the dashed line, will favor on-site generation. For example, if electrical power must be purchased at \$.03/KWH, digester gas must be sold for at least \$1.75/mmBTU before direct sale of the digester gas becomes more economical. Electrical power cost increases to as much as \$.05/KWH have been projected in the near future. At this rate, digester gas would have to command about \$3.75/mm BTU before direct sale would be economically favored. While this analysis is based on data developed for Hyperion, the results are reasonably accurate for all LA/OMA agencies.

Data presented above can also be used to determine the annual cost differences between alternatives. Consider, for example, purchase of electrical power at \$.04/KWH versus sale of digester gas at \$1/mmBTU, a value representative of present contractual arrangements (Hyperion currently sells gas to Scattergood at \$0.76/mmBTU). From Table VII-8, purchase of 217,000 KWH/day at Hyperion for \$.04/KWH would be worth \$8680/day or about 3.17 mm\$/yr. Since on-site generation costs about 0.96 mm\$/yr., the net value of generating 217,000 KWH/day is about 2.21 mm\$/yr. From Table VII-10 revenue from sale of digester gas would be about \$2180/day or 0.80 mm\$/yr. Thus, the cost difference between the two options is intended only as an illustration and each situation must be evaluated on its own site specific merits. However, considering the high probability of disproportionate increases in the future cost of purchased power and the relatively low unit prices received for digester gas in the past, on-site power generation has been assumed to be the most cost effective approach for the LA/OMA agencies. Only a rather drastic increase over present revenues received for digester gas would alter this conclusion.

STORAGE REQUIREMENTS

The application of storage facilities to the sludge processing flow train is necessary to assure system reliability and to assure that one unit process is not adversely affected by scheduling or operating differences in other unit processes. A requirement of 4 days total storage for liquid and dewatered cake (i.e. storage of liquid sludge plus storage of dewatered cake equals 4 days) has been assumed in this analysis. This is reasonably consistent with previous design practices. Existing wet cake storage facilities at JWPCP were designed for 3 days storage, based on analysis of historic rainfall patterns and landfill operating schedules. Facilities currently under design for OCSD will include one day liquid storage and 2 days on-site wet cake storage. In the present analysis a minimum of one day storage of liquid digested sludge was assumed to allow for operational downtime in mechanical dewatering facilities. When added to a requirement of 3 days wet cake storage, a total of 4 days for liquid and wet cake results.

The capital cost of providing liquid storage versus wet cake storage was evaluated using design criteria established during the assessment of alternatives and development of the Phase II facilities. Liquid sludge storage would be constructed in the same manner as an anaerobic digester, and capital costs were modelled assuming cost factors from anaerobic digestion. Costs for wet cake storage were based on construction costs for the existing facility at LACSD and recent design information developed by John Corollo Engineers for OCSD (Ref. 3). All capital costs were adjusted to an ENR of 3500 and include a 30 percent contingency factor. O & M costs were not evaluated and are not included in the following cost estimates.

A comparison of storage costs is shown in Figure VII-7 for the case of 1 MGD of digested sludge at 3.2 percent solids. The latter values are typical of projected Phase II conditions. The cost difference between liquid and wet cake storage depends largely on the cake solids achieved during dewatering. At 20 percent cake solids the cost difference is quite small. As cake solids approach 25 to 30 percent, the cost difference increases with the advantage going to wet cake storage.

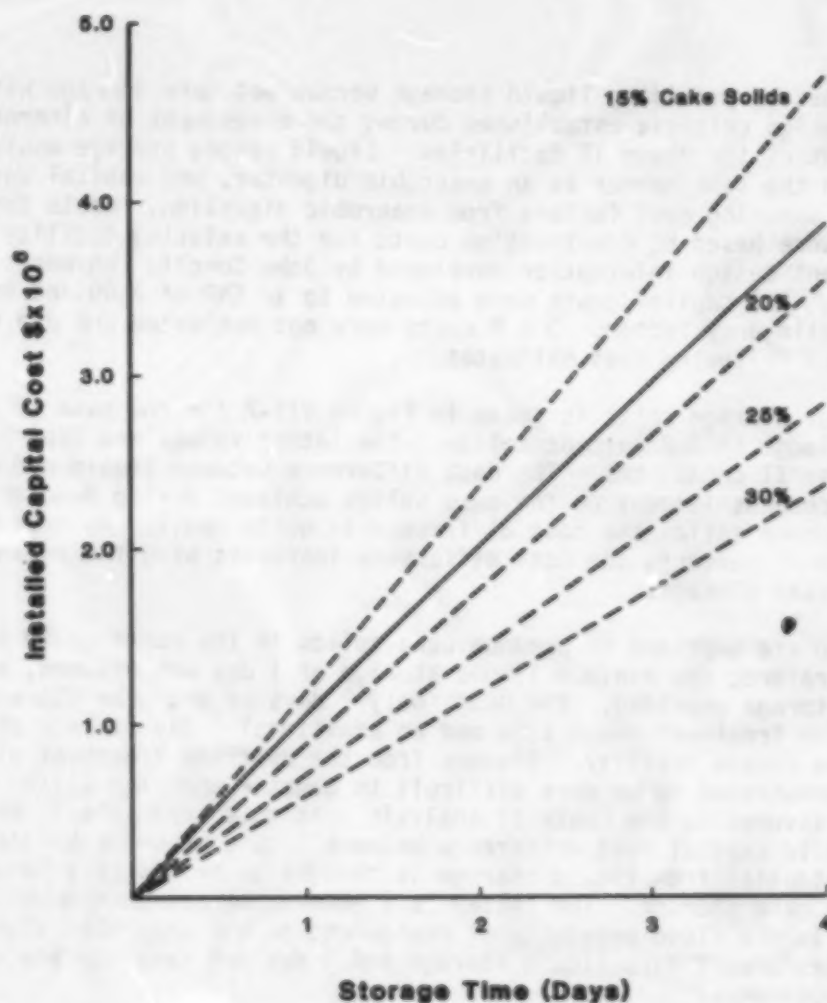
LACSD and OCSD are expected to produce cake solids in the range of 20 to 30 percent. Therefore, the minimum liquid storage of 1 day was assumed, and 3 days of wet cake storage provided. For OCSD, only 2 days of wet cake storage was provided at the treatment plant site and an additional 1 day storage at the proposed Round Canyon facility. Sludges from the Hyperion treatment plant (CLA) have been demonstrated to be more difficult to dewater and cake solids of 18 percent were assumed in the Phase II analysis. At this cake solids there should be little capital cost difference between liquid or wet cake storage. Also, odor potential from liquid storage is thought to be slightly less than that from wet cake storage. The latter is a more important consideration at Hyperion due to the close proximity of residences to the anaerobic digestion complex. Therefore, 3 days liquid storage and 1 day wet cake storage were assumed at Hyperion.

Three days storage for both dehydrated sludge product and char/ash are provided. Cost for these facilities is not considered significant relative to the cost of dehydration and thermal processing. Furthermore, the volume of material being stored is significantly reduced compared to liquid or wet cake storage.

The above assumptions were used for planning purposes and it is expected that further refinement of the storage requirements will occur during facility design. However, significant reduction in total storage capacity from values assumed here would have implications on overall system reliability and could jeopardize system performance. Intermediate storage should be considered an integral part of the total treatment train.

REDUNDANCY

The level of redundancy applied to the more conventional unit processes of thickening, digestion, mechanical dewatering, truck transport, and windrow composting are well within accepted standards of engineering practice. No further cost effective analysis is considered necessary for these processes.



— Liquid Storage
 - - - Wet Cake Storage

ENR = 3500
 Enclues Contingency
 of 30 percent
 1 mgd of Digested Sludge @ 3.2 percent solids
 Bulk weight = 62.4 lb/ft³

Capital Costs, \$
 Liquid Storage = 20.79 (volume, ft³) 0.92
 Wet Cake Storage = 1110 (volume, CY)

**LIQUID AND WET CAKE
 STORAGE COSTS**

RESEARCH SLUDGE MANAGEMENT PROGRAM
 LOS ANGELES-ORANGE COUNTY METROPOLITAN AREA

FIG. VII-7

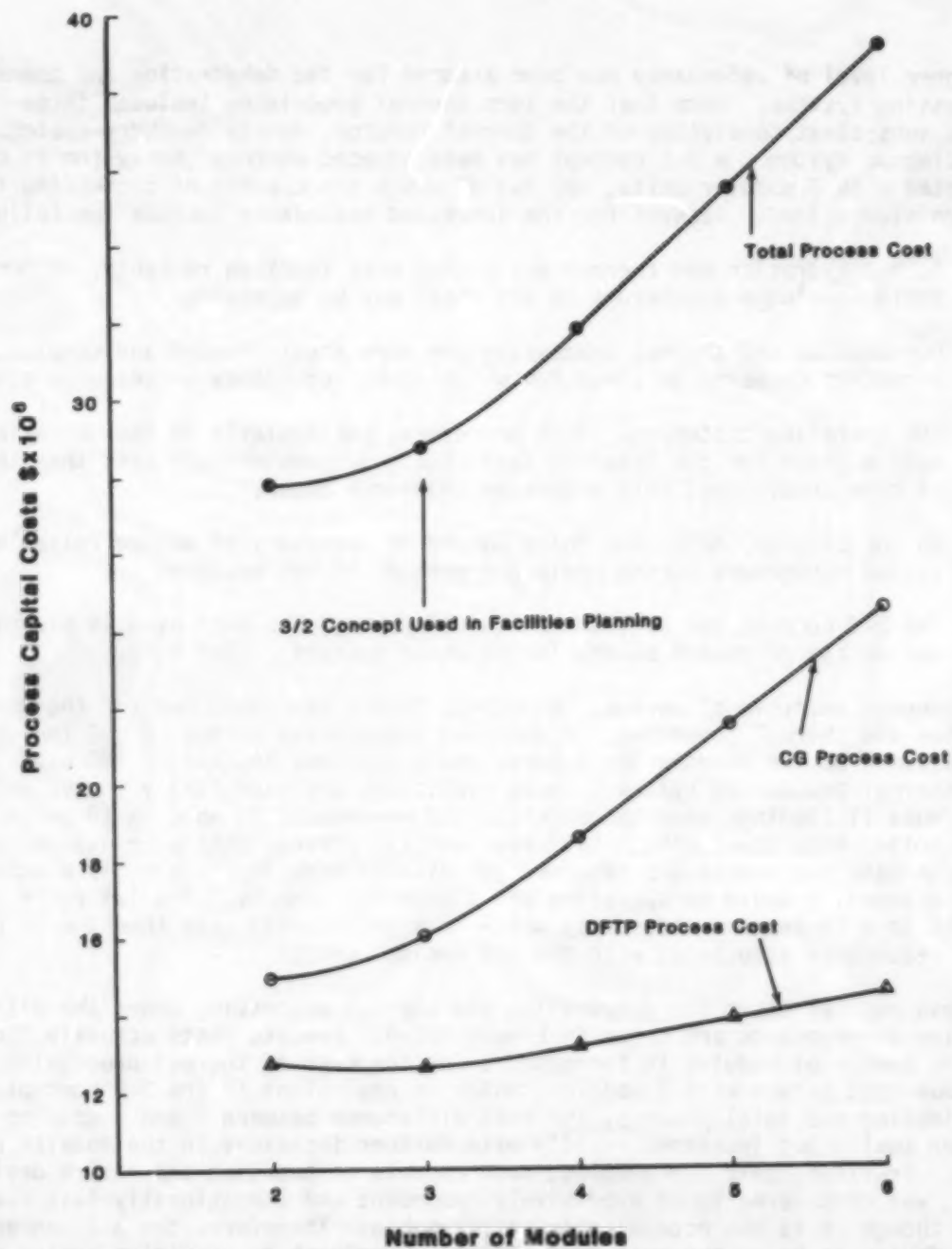
A higher level of redundancy has been assumed for the dehydration and thermal processing systems. Note that the term thermal processing includes three basic subsystems consisting of the thermal reactor, energy recovery system, and air cleanup system. A 3-2 concept has been adopted whereby the system is constructed with 3 modular units, any two of which are capable of processing the design sludge load. Reasons for the increased redundancy include the following:

- Both dehydration and thermal processing must function reliably. Otherwise, periodic sludge discharges to the ocean may be necessary.
- Dehydration and thermal processing are more sophisticated and complex unit processes compared to those for which lower redundancy values were assumed.
- The operating history of these processes, particularly in the operating mode planned for the Phase II facilities, is considerably less than that of more traditional unit processes mentioned above.
- In the case of LACSD, the third module is necessary to assure reliable sludge management during prolonged periods of wet weather.
- The 3-2 concept (or similar design redundancy) has been used in planning and design of recent sludge incineration systems. (Ref 4,5).

An economic analysis of various redundancy levels was conducted for the dehydration and thermal processes. A constant evaporative burden of 800 tpd (H_2O) was assumed on the dehydration system, and a constant loading of 200 wtpd into the thermal processing system. These conditions are essentially equivalent to the Phase II loadings expected at LACSD and correspond to about a 19 percent cake solids from dewatering. Different modular arrangements were assumed and in each case one module was reserved for standby capacity. Thus, if 6 modules were assumed, 5 would be operating and 1 used for standby. The latter is equivalent to a 25 percent redundancy which is significantly less than the 50 percent redundancy associated with the 3-2 design concept.

Process capital costs for dehydration and thermal processing under the different modular arrangements are shown in Figure VII-8. Process costs actually increase as the number of modules is increased. For the case of thermal processing, a minimum cost occurs with 3 modules, which is equivalent to the 3-2 concept. Considering the total process, the cost difference between 2 and 3 modules is rather small, but increases rapidly with further increases in the modular numbers. Providing only two modules, each capable of handling the entire design load, was considered to be excessively redundant and operationally less flexible, even though it is not economically unreasonable. Therefore, the 3-2 concept was adopted as being the most cost-effective approach to providing system redundancy.

An alternative approach to providing redundancy, not included in the analysis shown in Figure VII-8 would be to provide only 2 modules each capable of handling one-half the design load. Spare pumps and other key parts would then be provided for each module, but a complete backup module would not be available. Such an approach would have a lower capital cost than the 3-2 design concept. However, this approach is inconsistent with that used for other unit processes where complete standby units are provided, such as for thickening, dewatering, trucking,



EFFECT OF MODULE NUMBER ON CG AND DFTP PROCESS COSTS

INDIVIDUAL SALINE MANAGEMENT PROGRAM
LOS ANGELES/GRANDE COUNTY METROPOLITAN AREA

FIG. VII-8

and composting. It is generally considered acceptable engineering practice in municipal treatment plant design to provide an entire backup unit when possible. Therefore, providing internal redundancy within a module, while a necessary part of any system design, was not considered sufficient redundancy for municipal design. Also, the probability or frequency of occasional ocean discharge of sludge would be increased without the standby module. However, the increased risk is difficult to quantify due to lack of long term operating data for the complete treatment train being proposed.

It could be argued that facilities for emergency landfilling of sludge could be provided in place of a third module. Standby truck facilities would be somewhat less expensive than the cost of a third module. In the case of LACSD, however, emergency landfilling would not be consistent with wet weather requirements, for which the third module is necessary. For the City of Los Angeles, sludge disposal in landfills is not considered to be politically acceptable (Ref. 1). Therefore, the 3-2 modular concept is believed to be the most cost effective approach to providing system redundancy, recognizing the level of reliability required in municipal design and other site specific factors.

AIR POLLUTION CONTROL SYSTEMS

Capital and operating costs of air pollution control systems for NO_x , SO_x and particulates from the thermal processing system were evaluated with the aid of a consultant study by KVB, Inc. (Ref. 6). Different control systems with different pollutant removal efficiencies were identified. The estimated costs were calculated based on a digested sludge loading of 265 dry ton/day to the thermal processing unit, and a stack gas flow of 1805 ton/day or 33,000 standard cubic feet per minute. The above loading approximates the identified capacity for the Phase II facilities for the City of Los Angeles. It was chosen as the example for discussion. Similar costs are expected for the 2-module operating mode for the Phase II facilities of the LACSD.

NO_x control for the thermal processing system can be accomplished through the non-catalytic ammonia injection method with greater than 60 percent removal, or with the catalytic ammonia injection method with probably 90 per cent removal. However, there is concern over the technical reliability of the catalytic system for NO_x removal from dirty flue gas. Plugging, blinding and erosion of the catalyst may limit the viability of the catalytic system. Detailed cost for both systems as provided by KVB, Inc. is given in Table VII-11. Total annual cost of \$197,000 is projected for the noncatalytic system, with a unit cost of \$0.39 per lb of NO_x removed. Corresponding costs for the catalytic system are difficult to assess due to the uncertainties with catalyst life. However, the costs for the catalytic system are expected to be significantly higher.

In the Air Quality Management Plan for the South Coast Air Basin, various NO_x control strategies have been identified (Ref. 7). It is not known whether the control measures identified are presently available or appropriate for trade-off. However, in terms of cost effectiveness, control costs ranging from \$0.13/lb NO_x for emission control on stationary internal combustion engines, to \$130/lb NO_x for emission control on gas turbines were estimated.

TABLE VII-11

**NO_x CONTROL COSTS FOR THERMAL PROCESSING
OF 265 DTPC OF SLUDGE**

	<u>Non-Catalytic Ammonia Injection</u>	<u>Catalytic Ammonia Injection</u>
<u>System Parameters</u>		
Sludge Loading, dry ton/day	265	265
Stack Gas Flow, Ton/day	1805	1805
Std Ft ³ /min.	33,000	33,000
NO _x Conc., ppmv		
Inlet	400	400
Outlet	160	40
Control Efficiency, %	60	90
NO _x Mass Flow, lb/day		
Inlet	2290	2290
Outlet	916	230
Converted to N ₂	1374	2060
<u>Cost Parameters</u>		
Capital Costs		
Total	500,000	1,500,000 (estimate)
Annual(1), \$/yr.	47,000	140,000
Operating Cost(2), \$/yr.	150,000	(3)
Total Annual Costs, \$/yr.	197,000	-
Unit Cost for NO _x Conversion, \$/lb NO _x	0.39	

Cost Data Source:

KVB Inc., "LA/QMA Emissions and Emission Control Study", Prepared by W.J. Dennison & J.T. Leach, January 1980, Table 2.4.1.

(1) Amortized for 20 years @ 6-7/8%, amortization factor = 0.09349.

(2) Steam @ 12 ton/day and \$6/ton and ammonia @ \$170/ton.

(3) Difficult to assess cost due to uncertain catalyst cost.

SO₂ control for thermal processing can be accomplished through chemical removal either in a wet or a dry system. A wet system is more appropriate under the LA/OMA planning assumption of the use of multiple hearth furnaces. However, the dry system may be appropriate for the case of a fluidized bed reactor.

In general, two types of wet systems are available, one using limestone and the other lime as the chemical reagent. SO₂ removal efficiencies of 95 percent and 98 percent, respectively are judged to be obtainable. The cost data are summarized in Table VII-12. Total annual costs are \$292,000 and \$361,000 for the limestone and lime systems respectively. The main difference is in the cost of reagent. In terms of unit costs per lb of SO₂ removed, the two systems differ by about 20 percent, at \$0.11/lb SO₂ and \$0.13/lb SO₂ respectively. The Air Quality Management Plan has also identified potential SO₂ control measures (Ref. 8). Control costs ranging from \$0.15/lb SO₂ for 80 percent SO₂ reduction in petroleum cake calcining, to \$20.55/lb SO₂ for 88 percent SO₂ reduction from electric power generating equipment were estimated. Again, it is not known whether the control measures are available or appropriate for trade-off.

For particulate control, efficient capture of sub-micron particles is required of the control devices. Only electrostatic precipitator (ESP), fabric filter baghouse and the new electrostatic baghouse would meet the requirement. The ESP has a "window" of lower efficiency down to 95 percent for the 1.0 to 0.1 micron range, while the baghouse would maintain the capture efficiency of 99 percent or better throughout the size range. Both the ESP and conventional baghouse are expected to meet the LA/OMA design goal of particulate discharge of 0.01 gr/ACF.

Cost data for the three systems are given in Table VII-13. The cost data for the electrostatic baghouse are preliminary, and no operating cost data is available on the ESP for a sludge thermal processing operation. The conventional baghouse was estimated to cost about \$155,000/yr, with almost equal division between capital and operating expenses. The electrostatic baghouse is expected to cost in the same range as the conventional baghouse, trading off the increased cost of the precipitator with the lower cost of the smaller size baghouse required. No unit cost for particulate removal was calculated since no mass removal of particulate was determined. It is the outlet concentration from the control device that would be the designing factor. Particulates from sludge thermal processing is expected to contain high concentrations of volatile metals, and their efficient removal is essential. No similar type of particulates available for trade-off in the South Coast Air Basin appears evident.

Besides air pollutant control for the thermal processing system, control of NO_x and SO₂ from the combustion of digester gas may be required. NO_x control for the combined cycle power (CCP) system could be accomplished through water injection at the combustion zone or through ammonia injection to the flue gases.

Using the Phase II digester gas combustion facilities of the City of Los Angeles as an example, a total of 2891 mmBTU/day of digester gas would be combusted, with a flue gas volume of 4870 tons/day. The NO_x emission would be about 867 lb/day (full CCP use). Using a non-catalytic flue gas deNO_x system, reduction of 60 percent or 520 lb/day may be achievable. An approximate deNO_x system cost for the CCP system could be estimated based on corresponding cost information for the thermal processing system. For a rough estimate, the capital cost would be pro-rated by ratio of the flue gas volumes, and the operating costs ratio of

TABLE VII-12

**SO₂ CONTROL COSTS FOR THERMAL PROCESSING OF
265 DTPD OF SLUDGE**

<u>System Parameters</u>	<u>Limestone(CaCO₃) System</u>	<u>Lime(CaO) System</u>
Sludge Loading, ton/day	265	265
Stack Gas Flow, Ton/day	1805	1805
Std Ft ³ /min	33,000	33,000
SO ₂ Conc., ppm		
Inlet	1000	1000
Outlet	50	20
Control Efficiency, %	95	98
SO ₂ Mass Flow, lb/day		
Inlet	7980	7980
Outlet	399	160
Removed	7581	7820
<u>Cost Parameters</u>		
Capital Costs (3 units, 8' diam. tower)		
Total, \$	1,300,000	1,400,000
Annual(1), \$/yr.	122,000	131,000
Operating Costs, \$/yr.		
Reagent(2)	29,000	82,000
Water	2100	2100
Electricity	3900	3900
Maintenance	87,000	93,000
Operating labor	26,000	27,000
Administration	4,400	4,600
Overhead	14,000	14,000
Total	170,000	230,000
Total Annual Costs, \$/yr.	292,000	361,000
Unit Cost, \$/lb SO ₂	0.11	0.13

Cost Data Source:

KVB, Inc. "LA/OMA Emissions and Emission Control Study," Prepared by W.J. Dennison & J.T. Leach, January 1980, Table 2.4.3.

(1) Amortized for 20 years @ 6- /8%, amortization factor = 0.09

(2) Costs for limestone @ \$12/ton and lime @ \$60/ton; reagent/SO₂ mole ratio 1.1; reagent purity 95%.

TABLE VII-13
PARTICULATE CONTROL COSTS FOR THERMAL PROCESSING OF
265 DTPD OF SLUDGE

	ELECTROSTATIC PRECIPITATOR	CONVENTIONAL BAGHOUSE	ELECTROSTATIC BAGHOUSE(1)
<u>System Parameters</u>			
Sludge Loading, ton/day		265	
Control level, gr/ACF	0.01 or better	0.01 or better	0.0005
Particulate Flow, lb/day			
Calculated outlet(2)	117	117	6
Electricity Used, 10 ³ KWH/yr.	-	1292	526
<u>Cost Parameter</u>			
Capital Cost			
Total, \$	650,000	860,000	680,000
Annual(3), \$/yr.	61,000	80,000	64,000
Operating Cost, \$/yr.			
Maintenance		16,000	
Electricity		39,000	16,000
Bag replacement		8,000	
Administration		1800	
Overhead		10,000	
Total		75,000	(4)
Total Annual Costs, \$/yr.		155,000	

Cost Data Source:

KVB, Inc., "LA/QMA Emissions and Emission Control Study," Prepared by W.J. Dennison & J.T. Leach, January 1980, Table 2.4.2.

- (1) Data supplied by Apitron, vendor.
- (2) Stack gas volume 82.2 x 10⁶ ACF/Day @ 400°F was assumed.
- (3) Amortized for 20 years @ 6-7/8%, amortization factor = 0.09349.
- (4) Expected to be in the same range as conventional baghouse.

the pounds of NO_x removed. The resulted estimate would be \$120,000/yr for the capital cost and \$60,000/yr for the operating cost, giving a total of \$180,000/yr. On the other hand, cost for water injection for NO_x control may be considerably less. The \$180,000/yr figure could thus be considered as an estimated ceiling for practical deNO_x control for the CCP system.

Control of SO_2 emissions from digester gas combustion can be achieved through a variety of means. The sulfur content of the digester gas could be reduced through operational controls of the anaerobic sludge digestion process such as changing the pH of the digestion process or addition of metals like iron and zinc to precipitate sulfide in the sludge. Removal of hydrogen sulfide from the digester gas is another means for sulfur control and is perhaps more reliable and efficient. Dry processes, such as iron sponge, and wet processes, such as chemical scrubbing are commonly used for H_2S removal. Lastly, SO_2 could be removed from the flue gas by a alkaline scrubbing.

In conclusion, reliable and efficient air pollutant control systems for the thermal processing system are available. Taking the example of the Phase II facilities for the City of Los Angeles (265 DTPD of sludge), the non-catalytic ammonia injection system for NO_x control was estimated to cost \$197,000/yr. For SO_2 control, the wet lime scrubbing system was estimated to cost \$361,000/yr. The total of the air emission control system cost was estimated to be \$713,000/yr, (\$258,000/yr capital costs and \$455,000/yr operating costs).

To provide a perspective for air emission control costs, (and continuing the example of Phase II Facilities for the City of Los Angeles) the total annual capital costs for dehydration and thermal processing-waste heat recovery would be about \$5,311,000 per year. A contingency of 35% to 40% is included in the capital cost figure because of uncertainties of cost estimating. The capital costs of the air emission control system would be about 5% of the total capital costs for the dehydration and thermal processing systems. The operating costs for dehydration and thermal processing-waste heat recovery, without considering electrical credits, would be \$3,589,000/yr. Operating costs for the air emission control system would be about 13% the annual operating costs of the dehydration and thermal processing systems. In terms of the operating cost of the total sludge management system, air emission control systems would be about 5% of such cost. The incremental costs for air pollution control appear to be relatively small. The increases in capital costs may well be covered by the contingencies in the cost estimate.

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APPENDICES

APPENDIX A

**RESULTS OF COMPUTER ANALYSIS OF
ALTERNATIVE SLUDGE MANAGEMENT PROJECTS**

APPENDIX B

SLUDGE MANAGEMENT REPORT TOOL (SMART)

APPENDIX C

**PROCESS FLOW DIAGRAMS
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APPENDIX A

APPENDIX A

RESULTS OF COMPUTER ANALYSIS OF THE ALTERNATIVE SLUDGE MANAGEMENT PROJECTS

This appendix contains tabular summaries of the quantitative analysis of Sludge Management Projects. Data contained herein forms the basis for the analysis presented in Chapter IV. A summary under conditions of full secondary treatment is presented in Table 1A-1 and for marine secondary treatment in Table 1A-2.

KEY TO TABLES IN APPENDIX A

OPERATING AGENCIES

<u>Agency</u>	<u>Agency Name</u>
CLA	City of Los Angeles
LACSD	Los Angeles County Sanitation Districts
OCSD	Orange County Sanitation Districts

ALTERNATIVE SLUDGE MANAGEMENT PROJECTS

<u>Project Number</u>	<u>Project Name</u>
1-R-1	Solar Drying Basins
1-R-2	Desert Energy Project
2-R-1	Centralized Dewatering and Composting
2-S-1	Decentralized Dewatering and Composting
2-S-1x	Round Canyon Project - OCSD
3-R-1	Energy Recovery from Sludge and Dairy Waste
3-S-1	Energy Recovery from Sludge
3-S-2	Energy Recovery from Sludge and Solid Waste
4-S-1	Deep Ocean Outfalls
4-R-1	Barge Disposal
D-S-1	Truck Dewatered Cake to Landfills
6-S-1	Baseline "No Project" Alternative

TABLE 1A-1
FULL SECONDARY TREATMENT
SUMMARY OF QUANTITATIVE ANALYSIS OF SLUDGE PROJECTS

Sizing	IR1 J/PCP	IR1 CSDOC	IR1 HYPERION	IR1 SOUTH FORDS LANDFILL a/	IR2 STUDDARD VALLEY BURN a/	2R1 J/PCP	2R1 CSDOC	2R1 HYPERION
Loading (dry tons/day)	705.0	440.0	540.0	1,685.0	1,685.0	705.0	440.0	540.0
Land Area Required (acres)	8.2	5.2	4.7	3,343.9	3,346.1	8.5	5.6	5.0
Number of Employees per 24 hrs	37	31	37	126	139	37	31	37
Polymers Used (lbs/day)	553	568	695	1816	1816	553	568	695
Isonar L Used (gal/day)	0	0	0	0	0	0	0	0
Required Additional N2 for Recycle (tons/day)	0.0	0.0	0.0	4.3	4.3	0.0	0.0	0.0
Energy								
Electricity Used (kwh/day)	77498	68354	75648	454192	584989	80119	60920	78237
Electricity Produced (kwh/day)	339687	195047	239722	774456	1331866	350959	202950	249414
Fuel Oil Used (gal/day)	0	0	0	0	0	0	0	0
Fuel Produced (tons/day)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diesel Fuel Used (gal/day)	0	0	0	295	368	0	0	0
Elec. for Recycle N2 (kwh/day)	0	0	0	56	56	0	0	0

TABLE 1A-1 (Continued)

	1P1 J PCP	1P1 CSDUC	1P1 HYPERION	1P1 SOUTH EDWARDS LANDFILL	1P2 STUDANO VALLEY	2P1 J-PCP	2P1 CSDUC	2P1 HYPERION
COSTS								
Capital Cost								
Total Land Cost (\$000)	0	0	0	5987	5991	0	0	0
Total Process and Structural Cost (\$000)	57704	48060	51309	392036	460436	59636	49200	52916
Total Capital Cost (\$000)	57704	48060	51309	398023	466427	59636	49200	52916
Total Annual Capital Cost (\$000)	5200	4404	4702	36589	42881	5467	4509	4850
Operations and Maintenance Cost								
Labor (\$000/yr)	1603	1343	1603	5460	6023	1603	1343	1603
Diesel Fuel (\$000/yr)	0	0	0	43	54	0	0	0
Fuel Oil (\$000/yr)	0	0	0	0	0	0	0	0
Electricity (\$000/yr)	849	748	629	4974	6406	878	667	887
Polymers (\$000/yr)	403	415	507	1325	1325	403	415	507
Isopar L (\$000/yr)	7	0	0	0	0	0	0	0
Maintenance (\$000/yr)	363	254	298	1198	2650	373	256	307
Recycle Oxygen (\$000/yr)	0	0	0	34	34	0	0	0
Lump Charge (\$000/yr)	0	0	0	2084	459	0	0	0
Subtotal (\$000/yr)	3218	2760	3237	16533	18366	3257	2681	3274
Credits								
Sale of Carver-Greenfield (\$000/yr)	0	0	0	0	0	0	0	0
Sale of Compost (\$000/yr)	0	0	0	0	0	0	0	0
Sale of Fuel (\$000/yr)	0	0	0	0	0	0	0	0
Sale of Electricity (\$000/yr)	-3720	-2136	-2625	-8481	-14505	-3843	-2222	-2731
Refuse Tipping Fee (\$000/yr)	0	0	0	0	0	0	0	0
Refuse Resale (\$000/yr)	0	0	0	0	0	0	0	0
Subtotal (\$000/yr)	-3720	-2136	-2625	-8481	-14505	-3843	-2222	-2731

FULL

TABLE 1A-1 (Continued)

	1R1 JWPCP	1R1 CSDOC	1R1 HYPERION	1R1 SOUTH EDWARDS LANDFILL	1R2 STANDARD VALLEY	2R1 JWPCP	2R1 CSDOC	2R1 HYPERION
TOTAL ANNUAL OPERATING COST (\$/TON/YR)	-4.92	624	621	8063	3791	-586	460	552
TOTAL ANNUAL CAPITAL AND OPERATING COSTS (\$/TON/YR)	4788	5020	5323	44653	46673	4880	4969	5400
TOTAL ANNUAL COST/TON OF DRY FEED (\$/TON)	18.81	31.31	27.01	72.06	75.89	18.96	30.04	27.49

TABLE 1A-1 (Continued)

Sizing	251 CHINO COMPOST	251 JAPCP COMPOST	251 CSDUC COMPOST ON-SITE	251 CSDUC COMPOST RECYCLED	251 HYPERION COMPOST	351 CHINO MANURE 2/	351 JAPCP CAP-GRF BIURE	351 CSDUC CAP-GRF FURN
Loading (dry tons/day)	1,685.0	705.0	440.0	440.0	540.0	1,685.0	705.0	440.0
Land Area Required (acres)	175.1	47.9	30.8	48.6	35.7	59.6	12.9	9.2
Number of Employees per 24 hrs	199	73	61	80	71	196	69	57
Polymers Used (lbs/day)	12036	4389	3445	3445	4225	12036	4389	3445
Isopar L Used (gal/day)	0	231	278	0	341	3359	1392	883
Required Additional O2 for Recycle (tons/day)	5.0	2.7	1.9	1.5	2.3	10.1	3.9	2.7
Energy								
Electricity Used (kWh/day)	311887	96118	75888	62931	93013	596843	161785	119000
Electricity Produced (kWh/day)	803373	339192	185832	202950	228456	1778443	570384	347448
Fuel Oil Used (gal/day)	0	0	0	0	0	0	0	0
Fuel Produced (tons/day)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diesel Fuel Used (gal/day)	4617	222	140	2014	171	919	169	87
Elec. for Recycle O2 (kWh/day)	1708	815	584	469	716	3152	1215	815

TABLE 1A-1 (Continued)

	781 CHIRU COMPOST	251 JAPCP COMPOST	251 CSDMC COMPOST ON-SITE	251 CSDMC COMPOST PIPCYN	251 HYPERIUS COMPOST	381 CHIRU MANURE	381 JAPCP CAP-GHE BURN	381 CSDMC CAP-GHE BURN
COSTS								
Capital Cost								
Total Land Cost (\$000)	9354	0	0	2498	0	2430	0	0
Total Process and Structural Cost (\$000)	248190	102964	77180	49041	88044	354753	116667	90098
Total Capital Cost (\$000)	257545	102964	77180	51539	88044	357182	116667	90098
Total Annual Capital Cost (\$000)	21670	9438	7074	5070	8369	32889	10759	8280
Operations and Maintenance Cost								
Labor (\$000/yr)	8622	3164	2644	3466	3077	8368	2891	2471
Diesel Fuel (\$000/yr)	678	32	20	294	25	112	25	13
Fuel Oil (\$000/yr)	0	0	0	0	0	0	0	0
Electricity (\$000/yr)	3417	1052	831	689	1019	6501	1771	1302
Polymers (\$000/yr)	9785	3203	2515	2515	3044	8785	3203	2515
Isopar L (\$000/yr)	0	59	71	0	87	858	356	226
Maintenance (\$000/yr)	1791	1138	939	703	1082	5206	2104	1627
Recycle Oxygen (\$000/yr)	46	21	15	12	19	81	31	21
Dump Charge (\$000/yr)	0	0	0	0	0	620	205	115
Subtotal (\$000/yr)	23339	8669	7035	7679	8393	30531	10686	8290
Credits								
Sale of Carver-Greenfield (\$000/yr)	0	0	0	0	0	0	0	0
Sale of Compost (\$000/yr)	-894	-342	-208	-214	-255	0	0	0
Sale of Fuel (\$000/yr)	0	0	0	0	0	0	0	0
Sale of Electricity (\$000/yr)	-8796	-3714	-2035	-2222	-2502	-19474	-6246	-3805
Refuse Tipping Fee (\$000/yr)	0	0	0	0	0	1464	0	0
Refuse Resale (\$000/yr)	0	0	0	0	0	0	0	0
Subtotal (\$000/yr)	-9690	-4056	-2243	-2440	-2757	-18010	-6246	-3805

TABLE 1A-1 (Continued)

241 CHIN COMPOST	251 JWPCP COMPOST	251 CSDUC COMPOST ON-SITE	251 CSDUC COMPOST RACYN ^b	251 HYFFHON CO-POST	3R1 CH140 MANURE ^a	3S1 JWPCP CAP-GRS BURN	3S1 CSDUC CAP-GRS BURN
13661	4613	4792	5244	5636	12521	4440	4485
TOTAL ANNUAL OPERATING COST (\$6000/YR)							
37295	14051	11866	10307	13705	45410	15199	12775
TOTAL ANNUAL CAPITAL AND OPERATING COSTS (\$6000/YR)							
60.64	54.60	73.89	66.18	69.53	73.83	59.07	79.55
TOTAL ANNUAL COST/TON OF CHY FEED (\$/TON)							

TABLE 1A-1 (Continued)

	3S1 HYPERION CAR-GPE BURN	3S2 JMCPC RUF BURN	3S2 CSDOC RDF BURN	3S2 HYPERION RDF BURN	DS1 JMCPC LANDFILL	DS1 CSDOC LANDFILL	DS1 HYPERION LANDFILL
Sizing							
Loading (dry tons/day)	540.0	705.0	440.0	540.0	705.0	440.0	540.0
Land Area Required (acres)	9.1	17.4	12.7	13.9	10.5	7.0	6.7
Number of Employees per 24 hrs	68	115	92	115	86	64	86
Polymers Used (lbs/day)	4225	4389	3445	4225	4389	3445	4225
Isopar L Used (gal/day)	1084	0	0	0	0	0	0
Required Additional O2 for Recycle (tons/day)	3.2	2.4	1.5	1.8	2.4	1.5	1.8
Energy							
Electricity Used (kwh/day)	145898	172606	132054	161929	83771	62311	76358
Electricity Produced (kwh/day)	426648	638400	423919	520317	350959	203950	249414
Fuel Oil Used (gal/day)	0	0	0	0	0	0	0
Fuel Produced (tons/day)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diesel Fuel Used (gal/day)	147	859	696	928	1269	678	1399
Elec. for Recycle O2 (kwh/day)	1024	735	469	575	735	469	575

TABLE 1A-1 (Continued)

	351 HYPERION CAP-GRF P-20A	352 J-PCP BDF B-20A	352 CSOAC PBF M-20A	352 HYPERION P-20A	DS1 J-PCP LANDFILL S/	DS1 CSOAC LANDFILL S/	DS1 HYPERION LANDFILL S/
Costs							
Capital Cost							
Total Land Cost (\$000)	0	0	0	0	0	0	0
Total Process and Structural Cost (\$000)	101544	148714	115646	138823	51363	44328	51363
Total Capital Cost (\$000)	101544	148714	115646	138823	51363	44328	51363
Total Annual Capital Cost (\$000)	9361	13796	10718	12896	6134	4375	5214
Operations and Maintenance Cost							
Labor (\$000/yr)	2947	4649	3751	4649	3727	2773	3727
Diesel Fuel (\$000/yr)	22	107	86	116	185	99	204
Fuel Oil (\$000/yr)	0	0	0	0	0	0	0
Electricity (\$000/yr)	1598	1835	1399	1714	917	682	836
Polymers (\$000/yr)	3084	3203	2515	3084	3203	2515	3084
Isosar L (\$000/yr)	277	0	0	0	0	0	0
Maintenance (\$000/yr)	1893	2795	2191	2726	1116	692	1074
Recycle Oxygen (\$000/yr)	27	19	12	15	19	12	15
Dump Charge (\$000/yr)	141	410	290	355	1948	1418	1739
Subtotal (\$000/yr)	9849	13018	10244	12641	11115	8191	10679
Credits							
Sale of Carver-Greenfield (\$000/yr)	0	0	0	0	0	0	0
Sale of Compost (\$000/yr)	0	0	0	0	0	0	0
Sale of Fuel (\$000/yr)	0	0	0	0	0	0	0
Sale of Electricity (\$000/yr)	-1672	-6940	-4642	-5700	-3443	-2222	-2731
Refuse Tipping Fee (\$000/yr)	0	-1822	-1550	-1502	0	0	0
Refuse Resale (\$000/yr)	0	-518	-441	-511	0	0	0
Subtotal (\$000/yr)	-1672	-9330	-6633	-8143	-3413	-2222	-2731

TALBE 1A-1 (Continued)

	351 HYPERION CANDLER BURN	352 JWPCP RDF BURN	352 CSDOC RDF BURN	352 HYPERION RDF PUE	DS1 JWPCP LANDFILL	DS1 CSDOC LANDFILL	DS1 HYPERION LANDFILL
TOTAL ANNUAL OPERATING COST (\$000/YR)	5317	3687	3613	4518	7272	5970	7949
TOTAL ANNUAL CAPITAL AND OPERATING COSTS (\$000/YR)	14678	17482	14331	17415	13407	10346	13162
TOTAL ANNUAL COST/TON OF DRY FEED (\$/TON)	74.47	67.91	89.23	86.16	52.10	64.42	66.78

TABLE 1A-1 (Continued)

Sizing	4S1 JWPCP	4S1 CSDOC	4S1 HYPERION	4R1 a/ IN BIGHT	6S1 JWPCP BASELINE c/ CENTRIFUGE LANDFILL d/	6S1 CSDOC BASELINE c/ CENTRIFUGE LANDFILL d/	6S1 HYPERION BASELINE c/ CENTRIFUGE LANDFILL d/
Loading (dry tons/day)	705	440	540	1685	705.0	440.0	540.0
Land Area Required (acres)	8.2	5.2	4.7	18.1	30.2	6.2	5.6
Number of Employees per 24 hrs	40.3	34.3	40.3	133	77	39	52
Polymers Used (lbs/day)	553	568	695	1816	5164	2868	2475
Isopar L Used (gal/day)	0	0	0	0	0	0	0
Required Additional O2 for Recycle (tons/day)	0	0	0	0	2.0	1.0	0.8
Energy							
Electricity Used (kWh/day)	70171	53284	64472	183000	83581	59640	69011
Electricity Produced (kWh/day)	339687	195047	239722	774456	380194	214429	255771
Fuel Oil Used (gal/day)	0	0	0	0	0	0	0
Fuel Produced (tons/day)	0	0	0	0	0.0	0.0	0.0
Diesel Fuel Used (gal/day)	35	17	17	10000	1828	393	775
Flec. for Recycle O2 (kWh/day)	0	0	0	0	634	326	355

TABLE 1A-1 (Continued)

COSTS	4SI JWPCP	4SI e/	4SI CSDOC	4SI HYPERION	4RI IN BIGHT	6SI JWPCP	6SI LACSD	6SI HYPERION

TABLE 1A-1 (Concluded)

	481 JWPCP e/	481 CSDOC e/	481 HYPERION e/	481 IN BIGHT a/	681 JWPCP BASELINE c/BASELINE c/ CENTRIFUGE CENTRIFUGE LANDFILL d/LANDFILL d/	681 CSDOC BASELINE c/BASELINE c/ CENTRIFUGE CENTRIFUGE LANDFILL d/LANDFILL d/	681 HYPERION BASELINE c/BASELINE c/ CENTRIFUGE CENTRIFUGE LANDFILL d/LANDFILL d/
TOTAL ANNUAL OPERATING COST (\$000/YR)	-395	604	648	6520	6431	3627	3476
TOTAL ANNUAL CAPITAL AND OPERATING COSTS (\$000/YR)	7207	6932	7850	24600	12343	7185	7597
TOTAL ANNUAL COST/TON OF DRY FEED (\$/ton)	28.01	43.16	39.82	40.00	48.74	46.08	38.54

a/ Tabular summary is for total project and includes individual plant processing.

b/ See "Quantitative Analysis of Sludge Management Projects" for further analysis of land area requirements.

c/ Indirect emissions which may result from combustion of landfill gas are not included.

d/ Includes ocean outfall of sludge where applicable.

e/ Includes new sludge outfall to approximately 1000 foot depth.

TABLE 1A-2
MARINE SECONDARY TREATMENT
SUMMARY OF QUANTITATIVE ANALYSIS OF SLUDGE PROJECTS

Sizing	IP1 J-PCP	IP1 CSUC	IP1 HYPERION	IP1 SOUTH EDWARDS LANDFILL $\frac{a}{b}$	IP2 STODDARD VALLEY $\frac{a}{b}$	2P1 JAPCP	2P1 CSUC	2P1 HYPERION
Loading (dry tons/day)	658.0	356.0	404.0	1,418.0	1,418.0	658.0	356.0	404.0
Land Area Required (acres)	6.7	2.6	0.6	2,783.3	2,785.4	7.0	2.9	0.9
Number of Employees per 24 hrs	31	24	25	101	113	31	25	25
Polymers Used (lbs/day)	404	303	265	972	972	404	303	265
Isosar I, Used (gal/day)	0	0	0	0	0	0	0	0
Required Additional O ₂ for recycle (tons/day)	0.0	0.0	0.0	3.4	3.4	0.0	0.0	0.0
Energy								
Electricity Used (kwh/day)	66602	43418	47686	379341	481643	68894	45474	49671
Electricity Produced (kwh/day)	379451	176752	210103	716306	1156794	339659	182753	216715
Fuel Oil Used (gal/day)	0	0	0	0	0	0	0	0
Fuel Produced (tons/day)	0.0	0.0	0.0	6.0	9.0	0.0	0.0	0.0
Diesel Fuel Used (gal/day)	0	0	0	254	326	0	0	0
Elec. for Recycle O ₂ (kwh/day)	0	0	0	44	44	0	0	0

TABLE 1A-2 (Continued)

CUSTS	1P1 JAPCP	1R1 CSUOC	1R1 HYPERION	1R1 SOUTH ENDERS LANDFILL a/	1R2 STODDARD VALLEY a/	2R1 JAPCP	2R1 CSUOC	2R1 HYPERION
Capital Cost								
Total Land Cost (\$000)	0	0	0	4942	4996	0	0	0
Total Process and Structural Cost (\$000)	44014	29024	20379	287210	355332	49823	30091	22436
Total Capital Cost (\$000)	44014	29024	20379	292122	360328	49823	30091	22436
Total Annual Capital Cost (\$000)	4402	2461	1867	26882	33146	4567	2758	2054
Operations and Maintenance Cost								
Labor (\$000/yr)	1343	1083	1083	4375	4895	1343	1083	1083
Diesel Fuel (\$000/yr)	0	0	0	37	47	0	0	0
Fuel Oil (\$000/yr)	0	0	0	0	0	0	0	0
Electricity (\$000/yr)	779	480	522	4153	5273	755	498	544
Polymers (\$000/yr)	295	221	194	710	710	295	221	194
Isopar L (\$000/yr)	0	0	0	0	0	0	0	0
Maintenance (\$000/yr)	332	195	209	976	2460	341	206	215
Percycle Oxygen (\$000/yr)	0	0	0	27	27	0	0	0
Dump Charge (\$000/yr)	0	0	0	1711	395	0	0	0
Subtotal (\$000/yr)	2699	1979	2008	13113	14671	2734	2002	2036
Credits								
Sale of Carver-Greenfield (\$000/yr)	0	0	0	0	0	0	0	0
Sale of Compost (\$000/yr)	0	0	0	0	0	0	0	0
Sale of Fuel (\$000/yr)	0	0	0	0	0	0	0	0
Sale of Electricity (\$000/yr)	-3607	-1935	-2301	-7843	-12666	-3719	-2001	-2173
Refuse Tipping Fee (\$000/yr)	0	0	0	0	0	0	0	0
Refuse Resale (\$000/yr)	0	0	0	0	0	0	0	0
Subtotal (\$000/yr)	-3607	-1935	-2301	-7843	-12666	-3719	-2001	-2373

MARINE

TABLE 1A-2 (Continued)

	1R1 J-PCP	1R1 CSDUC	1R1 HYPERION	1R1 SOUTH ENDLANDS LANDFILL a/	1R2 STODDARD VALLEY b/ BURN c/	2R1 J-PCP	2R1 CSDUC	2R1 HYPERION
TOTAL ANNUAL OPERATING COST (\$000/yr)	-907	43	-285	5279	2214	-985	0	-327
TOTAL ANNUAL CAPITAL AND OPERATING COSTS (\$000/yr)	1494	2704	1582	32159	35359	3582	2760	1729
TOTAL ANNUAL COST/TON OF DRY FEED (¢/ton)	14.55	20.81	10.73	62.13	68.32	14.91	21.24	11.73

TABLE 1A-2 (Continued)

Sizing	2d1 CHINA COMPOST	2d1 JAPCP COMPOST	2d1 CSDOC COMPOST ON-SITE	2d1 CSDOC COMPOST FACILITY	2d1 CSDOC COMPOST b/ HYPERSTON COMPOST	3d1 CHINA a/ -ACIDE	3d1 JAPCP CAP-GRE BUK	3d1 CSDOC CAP-GRE BUK
Loading (dry tons/day)	1,418.0	658.0	356.0	356.0	104.0	1,418.0	658.0	356.0
Land Area Required (acres)	121.5	43.5	24.8	31.5	20.7	48.6	11.2	5.9
Number of Employees per 24 hrs	150	66	51	60	51	162	62	48
Polymers Used (lbs/day)	8373	3764	2266	2266	2324	8373	3764	2266
Isopar L Used (gal/day)	0	147	96	0	134	2757	1286	694
Required Additional N2 for Recycle (tons/day)	4.4	2.4	1.3	1.2	1.4	7.8	3.5	2.0
Energy								
Electricity Used (kwh/day)	250577	82554	49398	43815	52313	480669	142884	83857
Electricity Produced (kwh/day)	739127	332592	177648	182783	210168	1619663	542027	298433
Fuel Oil Used (gal/day)	0	0	0	0	0	0	0	0
Fuel Produced (tons/day)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diesel Fuel Used (gal/day)	3252	206	125	1373	111	887	161	77
Elec. for Recycle O2 (kwh/day)	1496	728	406	372	463	2417	1099	419

TABLE 1A-2 (Continued)

COSTS	2M1 CHIMP COMPOST ^a /	2S1 JAPCP COMPOST	2S1 CSDOC COMPOST ON-SITE	2S1 CSDOC COMPOST ^b /	2S1 CSDOC COMPOST ^b /	3R1 CHIMP ^a /	3S1 JAPCP COMPOST ^b /	3S1 CSDOC COMPOST ^b /
Capital Cost								
Total Land Cost (\$000)	6639	0	0	1658	0	2265	0	0
Total Process and Structural Cost (\$000)	166726	88859	52913	27045	43427	270523	102542	63827
Total Capital Cost (\$000)	173365	88859	52913	28704	43427	272786	102542	63827
Total Annual Capital Cost (\$000)	15943	8145	4849	2883	3981	25143	9464	5882
Operations and Maintenance Cost								
Labor (\$000/yr)	6499	2860	2210	2600	2210	6895	2687	2081
Diesel Fuel (\$000/yr)	475	30	18	201	16	107	24	11
Fuel Oil (\$000/yr)	0	0	0	0	0	0	0	0
Electricity (\$000/yr)	2745	905	541	479	573	5230	1565	918
Polymers (\$000/yr)	6113	2748	1654	1654	1697	6113	2748	1654
Isopar L (\$000/yr)	0	38	25	0	34	705	329	177
Maintenance (\$000/yr)	1408	1041	745	514	782	4487	1959	1342
Pecycle Oxygen (\$000/yr)	38	19	11	10	12	62	29	16
Dump Charge (\$000/yr)	0	0	0	0	0	557	193	94
Subtotal (\$000/yr)	17279	7641	5204	5458	5324	24156	9534	6241
Credits								
Sale of Carver-Greenfield (\$000/yr)	0	0	0	0	0	0	0	0
Sale of Compost (\$000/yr)	-734	-318	-188	-169	-166	0	0	0
Sale of Fuel (\$000/yr)	0	0	0	0	0	0	0	0
Sale of Electricity (\$000/yr)	-8093	-3642	-1945	-2001	-2301	-17735	-5935	-3268
Refuse Tipping Fee (\$000/yr)	0	0	0	0	0	1464	0	0
Refuse Resale (\$000/yr)	0	0	0	0	0	0	0	0
Subtotal (\$000/yr)	-8427	-3960	-2133	-2170	-2467	-16271	-5935	-3268

MARINE

TABLE 1A-2 (Continued)

2P1 CHINO COMPOST $\frac{a}{b}$	2S1 JWPCP COMPOST	2S1 CSDOC COMPOST ON-SITE	2S1 CSDOC COMPOST HYCYN $\frac{b}{c}$	2S1 HYPERION COMPOST	3P1 CHINO MANURE $\frac{a}{b}$	3S1 JWPCP CAN-GRE BURN	3S1 CSDOC CAN-GRE BURN
8459	3681	3071	3287	2857	7885	3599	3025
TOTAL ANNUAL OPERATING COST (\$000/YR)							
24380	11826	7920	6166	6838	33028	13063	8907
TOTAL ANNUAL CAPITAL AND OPERATING COSTS (\$000/YR)							
47.10	49.24	60.95	47.45	46.37	64.27	54.39	68.55
TOTAL ANNUAL COST/TON OF DRY FEED (\$/ton)							

TABLE 1A-2 (Continued)

Sizing	351 HYPERION CAP-CRF BURN	352 JAPCP RDF BURN	352 CSDUC RDF BURN	352 HYPERION RDF BURN	DS1 JAPCP LANDFILL C/	DS1 CSDUC LANDFILL C/	DS1 HYPERION LANDFILL C/
Loading (dry tons/day)	404.0	658.0	356.0	404.0	658.0	356.0	404.0
Land Area Required (acres)	4.1	14.5	7.6	5.5	4.8	3.9	2.0
Number of Employees per 24 hrs	49	96	72	73	76	49	55
Polymers Used (lbs/day)	2324	3764	2298	2324	3764	2266	2324
Isobar L Used (gal/day)	777	0	0	0	0	0	0
Required Additional O ₂ for Recycle (tons/day)	2.1	2.2	1.2	1.3	2.2	1.2	1.3
Energy							
Electricity Used (kWh/day)	88975	150084	88954	91919	73412	43406	45750
Electricity Produced (kWh/day)	347251	589880	322116	368862	339659	182753	216715
Fuel Oil Used (gal/day)	0	0	0	0	0	0	0
Fuel Produced (tons/day)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diesel Fuel Used (gal/day)	118	739	418	488	1136	492	878
Elec. for Recycle O ₂ (kWh/day)	675	680	372	419	680	372	419

TABLE 1A-2 (Continued)

COSTS	3S1 HYPERION CAP-GPF RUPN	3S2 J-PCF PDF RUPN	3S2 CSDNC PDF RUPN	3S2 HYPERION PDF RUPN	DS1 J-PCF LANDFILL	DS1 CSDNC LANDFILL	DS1 HYPERION LANDFILL	
Capital Cost								
Total Land Cost (\$000)	0	0	0	0	0	0	0	0
Total Process and Structural Cost (\$000)	57577	120964	77665	69857	50208	24278	16881	
Total Capital Cost (\$100)	57577	120969	77665	69857	50208	24278	16881	
Total Annual Capital Cost (\$000)	5321	11229	7195	6501	5055	2451	1860	
Operations and Maintenance Cost								
Labor (\$000/yr)	2124	3925	2885	2928	3293	2123	2383	
Diesel Fuel (\$000/yr)	17	93	51	62	166	72	128	
Fuel Oil (\$000/yr)	0	0	0	0	0	0	0	
Electricity (\$000/yr)	974	1599	945	980	805	475	501	
Polymers (\$000/yr)	1697	2748	1678	1697	2748	1654	1697	
Isobut L (\$000/yr)	104	0	0	0	0	0	0	
Maintenance (\$000/yr)	1429	2354	1625	1693	1005	508	689	
Percycle Oxygen (\$000/yr)	18	18	10	11	18	10	11	
Dump Charge (\$000/yr)	108	364	208	207	1728	994	1053	
Subtotal (\$000/yr)	6564	11101	7402	7578	9763	5836	6462	
Credits								
Sale of Carver-Greenfield (\$000/yr)	0	0	0	0	0	0	0	
Sale of Compost (\$000/yr)	0	0	0	0	0	0	0	
Sale of Fuel (\$000/yr)	0	0	0	0	0	0	0	
Sale of Electricity (\$000/yr)	-3802	-6459	-3527	-4030	-3719	-2001	-2373	
Refuse Tipping Fee (\$000/yr)	0	-1516	-934	-877	0	0	0	
Refuse Resale (\$000/yr)	0	-431	-265	-249	0	0	0	
Subtotal (\$000/yr)	-3802	-8406	-4726	-5165	-3719	-2001	-2373	

MARINE

TABLE 1A-2 (Continued)

	3S1 HYPERION CAP-ORF HUPN	3S2 JAPCP RDF HUPN	3S2 CSDOC RDF BURN	3S2 HYPERION RDF HUPN	DS1 JAPCP C/ LANDFILL	DS1 CSDOC C/ LANDFILL	DS1 HYPERION C/ LANDFILL
TOTAL ANNUAL OPERATING COST (\$000/YR)	2764	2693	2675	2414	6044	3035	4089
TOTAL ANNUAL CAPITAL AND OPERATING COSTS (\$000/YR)	8085	13921	9870	8915	11099	6288	5949
TOTAL ANNUAL COST/TON OF DRY FEED (¢/ton)	54.83	57.96	75.96	60.46	46.21	49.39	40.34

MARINE

TABLE 1A-2 (Continued)

Sizing	4SI JWPCP e/	4SI CSDOC e/	4SI HYPERION e/	4SI IN BIGHT a/	6SI JWPCP e/ BASELINE d/	6SI CSDOC e/ BASELINE d/	6SI HYPERION e/ BASELINE d/
Loading (dry tons/day)	658.0	356.0	404.0	1418.0	658.0	356.0	404.0
Land Area Required (acres)	6.7	0.0	0.6	7.3	28.7	3.8	1.4
Number of Employees per 24 hrs	34	28	28	133	80	39	49
Polymers Used (lbs/day)	404	303	265	972	5015	2603	2045
Isopar L Used (gal/day)	0	0	0	0	0	0	0
Required Additional O2 for Recycle (tons/day)	0	0	0	0	2.0	1.0	0.8
Energy							
Electricity Used (kwh/day)	60860	36360	38000	133170	74794	42990	42728
Electricity Produced (kwh/day)	329450	176752	210100	716300	366046	194464	224099
Fuel Oil Used (gal/day)	0	0	0	0	0	0	0
Fuel Produced (tons/day)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diesel Fuel Used (gal/day)	35	17	17	8070	1821	384	768
Elec. for Recycle O2 (kwh/day)	0	0	0	0	629	322	252

TABLE 1A-2 (Continued)

COSTS	451 e/ JUPCT	451 e/ CSDOC	451 e/ HYPERION	481 a/ IN BIGHT	581 c/ JWCP BASELINE	651 CSIOC BASELINE	651 C/HYPERION c/ BASELINE
Capital Cost							
Total Land Cost (\$000)	0	0	0	0	0	0	0
Total Process and Structural Cost (\$000)	73700	52500	49979	141560	52006	22390	14014
Total Capital Cost (\$000)	73700	52500	49979	141560	52006	22390	14014
Total Annual Capital Cost (\$000)	6720	4760	4528	12960	5255	2224	1554
Operations and Maintenance Cost							
Labor (\$000/yr)	1446	1190	1186	4600	3467	1690	2123
Diesel Fuel (\$000/yr)	5	2.5	2.5	185	266	56	112
Fuel Oil (\$000/yr)	0	0	0	0	0	0	0
Electricity (\$000/yr)	667	400	416	1810	818	471	468
Polymers (\$000/yr)	295	220	194	710	3661	1900	1493
Isopar L (\$000/yr)	0	0	0	0	0	0	0
Maintenance (\$000/yr)	377	228	242	1030	872	366	532
Recycle Oxygen (\$000/yr)	0	0	0	0	16	8	6
Dump Charge (\$000/yr)	31	17	21	4580	1916	1281	975
Subtotal (\$000/yr)	2820	2060	2060	12900	11016	5772	5709
Credits							
Sale of Carver-Greenfield (\$000/yr)	0	0	0	0	0	0	0
Sale of Compost (\$000/yr)	0	0	0	0	-71	0	0
Sale of Fuel (\$000/yr)	0	0	0	0	0	0	0
Sale of Electricity (\$000/yr)	-3607	-1935	-2301	-7843	-4008	-2129	-2454
Refuse Tipping Fee (\$000/yr)	0	0	0	0	0	0	0
Refuse Resale (\$000/yr)	0	0	0	0	0	0	0
Subtotal (\$000/yr)	-3607	-1935	-2301	-7843	-4079	-2129	-2454

MARINE

TABLE 1A-2 (Concluded)

	4S1 g/ JWPCP	4S1 g/ CSDOC	4S1 g/ HYPERION	4R1 g/ IN BIGHT	6A1 JWPCP BASELINE	6A1 CSDOC BASELINE	6A1 HYPERION BASELINE
TOTAL ANNUAL OPERATING COST (\$000/YR)	-787	120	-240	5058	6938	3643	3256
TOTAL ANNUAL CAPITAL AND OPERATING COSTS (\$000/YR)	5933	4900	4280	18000	12192	5868	4810
TOTAL ANNUAL COST/TON OF DRY FEED (\$/ton)	24.70	37.71	29.08	34.78	50.76	45.16	32.62

a/ Tabular summary is for total project and includes individual plant processing.

b/ See "Quantitative Analysis of Sludge Management Projects" for further analysis of land area requirements.

c/ Indirect emissions which may result from combustion of landfill gas are not included.

d/ Includes ocean outfall of sludge where applicable.

e/ Includes new sludge outfall to approximately 1000 foot depth.

APPENDIX B

APPENDIX B

SLUDGE MANAGEMENT ALTERNATIVE REPORT TOOL (SMART)

The Sludge Management Alternative Report Tool (SMART) is a computer based management tool for the evaluation of alternative sludge management systems. This tool was developed for the LA/OMA Project by CH2M Hill and used for analysis of the fundamental Sludge Management Alternatives and alternative Sludge Management Projects.

The selection of the optimum series of sludge handling unit processes often requires the evaluation of many different alternatives. The time and effort involved in this process for manual evaluation usually requires that the number of alternatives considered be limited. SMART (Sludge Management Alternative Report Tool) gives the user the opportunity to examine more alternatives than could economically be done by manual analysis. The advantages of using this program are the following: (1) A large number of sludge management alternatives may be analyzed, giving the engineer the opportunity to select the most promising ones for a more thorough study; (2) An order-of-magnitude cost estimate may be made for a sludge process train for preliminary planning purposes.

SMART is divided into three parts: mass balance, process sizing/cost, and summary. The mass balance portion computes the mass of solids and water that flows into each process, flows out of each process, and that which is recycled by each process. The process sizing portion determines how many units are required (i.e., number of digesters required), the energy consumption, the cost, and the air emissions. The summary portion presents information in a reduced format to facilitate processing train comparison.

SMART 1 is a companion program to SMART and is used to produce a listing of process input files. Another companion program, SUMALL, is designed to provide the user with a composite summary report. A logic flow chart of the main-line program are given in Table 1. A detailed discussion of the SMART Program is given in Reference 1.

For each of the unit processes, design, cost, energy and emission factors were developed and formed the basis of the data input and the calculation procedure for the particular process. A detailed listing of all the factors for each of the processes is given in Reference 2. As an example, for the Direct Fired Thermal Processing (DFTP) unit process, parameters such as minimum after-burner temperature, excess air ratio, unit sizing requirements, furnace capacity, redundancy factors, and unit capital and operational costs are input to the program. A listing of the process variables for the DFTP unit process is given in Table 2. A printout of the input data is given in Table 3.

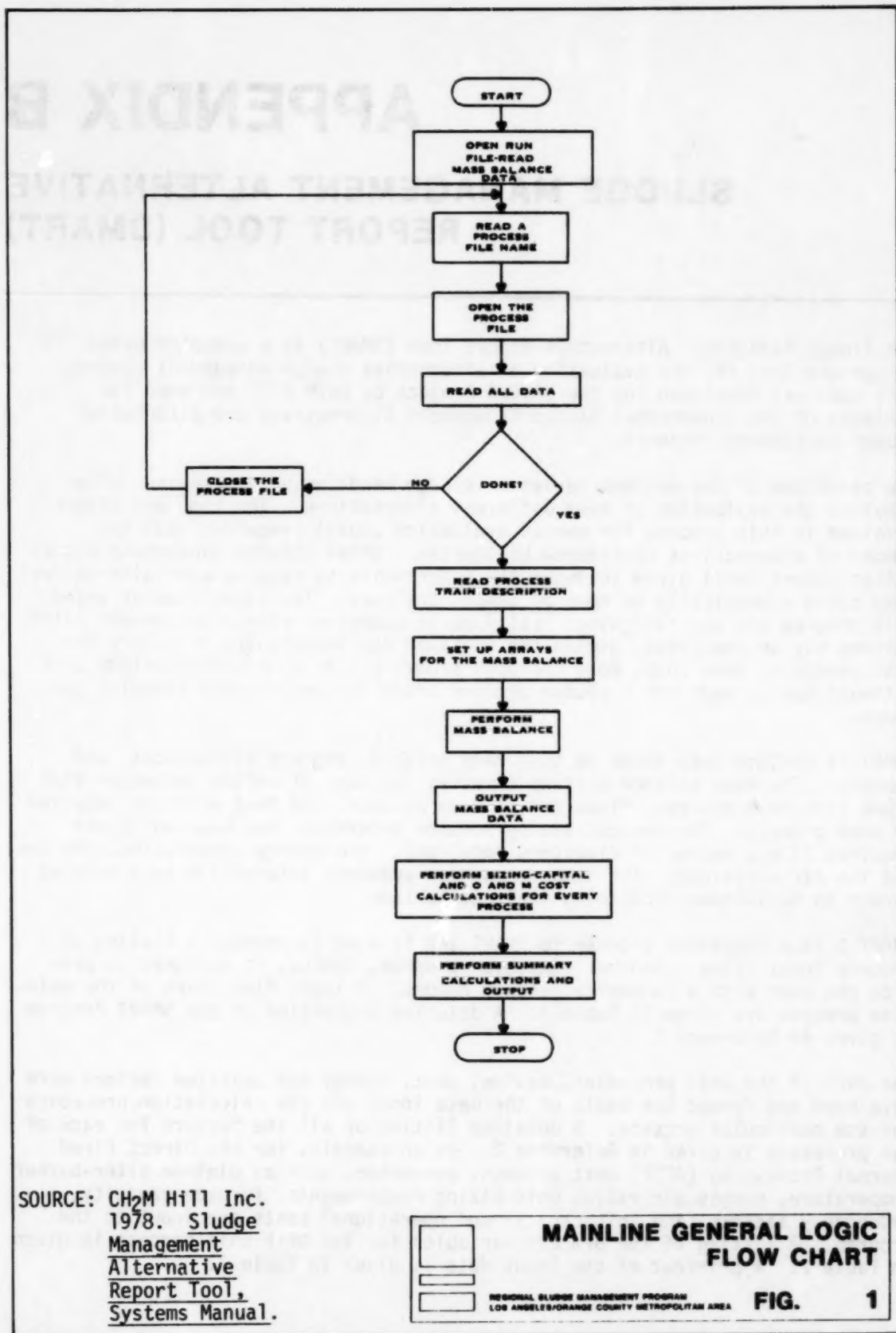


TABLE 1

SLUDGE MANAGEMENT UNIT PROCESS PROVIDED IN THE SMART PROGRAM

Dummy Unit Process
Flow Split Unit Process
Dissolved Air Flotation (DAF) Thickening
Thermal Pretreatment-Conditioning
Anaerobic Digestion (ANA 1)
Sidestream Anaerobic Digestion (ANA 2)
Combined Cycle Power Generation
Gravity Thickening
Centrifuge Dewatering
Belt Press Dewatering
Carver-Greenfield Dehydration
Refuse Derived Fuel (RDF) Production
Direct Fired Thermal Processing (DFTP)
Pyrolysis (PUROX)
Sludge Pipelines
Solar Drying
Windrow Sludge Composting
PHD Composting
Sludge Recycle Center
Committed Agricultural Use
Secondary Effluent Pipeline
Truck Transport

TABLE 2

PROCESS VARIABLES IN COMPUTER PROGRAM
FOR DIRECT FIRED THERMAL PROCESSING (DFTP)

Minimum Afterburner Temperature	1400°F
Pyrolysis Air Required	280 lbs/ (10 ⁶) Btu
Afterburner Air	2.5 x pyrolysis air
Steam Turbine Efficiency	78%
Furnace Building Area	8,125 ft ² per furnace
Power Building Area	0.35 ft ² per kW
Gross Land Area	16,900 ft ² per furnace plus 1.26 ft ² per kW
Capital Cost of Power Generation	\$200 per kW
Capital Cost of Furnace	\$11,000,000 each
Cost of RDF Storage and Feed	(500 x wet RDF t/d) ¹ / ₂ x \$1,000

Labor

RDF (if used)		0.33 position per furnace	
Furnace Loading	LE	1,200 (t/d)	5 positions
GT 1,300	LE	3,900	10 positions
GT 3,900	LE	6,500	15 positions
GT 6,500	LE	8,007	20 positions
GT 8,007	LE	10,833	25 positions
GT 10,000	LE	13,000	30 positions

TABLE 3

DATA INPUTS TO DIRECT FIRED THERMAL PROCESSING
PROCESS FILE

SIZING DATA

1. Fuel Value of Sludge	9100 (btu/lb.vss)
2. RDF Fuel Value	6000 (btu/lb)
3. RDF Moisture Content	20 (percent)
4. Ash	0.12 (lbs ash/lb wet RDF fed)
5. Ash	0.15 (lbs ash/lb dry sludge fed)
6. Afterburner Efficiency	0.85 (fraction)
7. Redundancy Factor	0.80 (fract full cap)
8. Furnace Loading Rate	650 (wet tons/day/furn)
9. Power Usage	75 (kwh/ton wet mix)
10. Assumed Density of Ash	55 (lbs/cu.ft.)
11. Particulate Emissions	0.05 (grains/DSCF stackgas)
12. NOX Emissions (Sludge-Refuse)	0.596 (lbs/dry ton stackgas)
13. NOX Emissions (Low Sulfur Oil)	0.155 (lbs/mmbtu)
14. SO2 Emissions (Sludge-Refuse)	0.243 (lbs/dry ton stackgas)
15. SO2 Emissions (Low Sulfur Oil)	0.100 (lbs/mmbtu)

CAPITAL COST DATA

1. Land Input ENR	3031
2. Process Input ENR	3031
3. Structural Input ENR	3031
4. Output ENR	3031
5. Land Fraction Contingency	0.20 (decimal)
6. Land Amortization Rate	0.06625 (decimal)
7. Land Amortization Period	20 (years)
8. Process Fraction Contingency	0.35 (decimal)
9. Structural Cost	63.20 (\$/sq.ft.)
10. Structural Fract Contingency	0.35 (decimal)
11. Process Amortization Rate	0.06625 (decimal)
12. Process Amortization Period	20 (years)

OPERATION AND MAINTENANCE COST DATA

1. Labor Cost	12.50 (\$/hour)
2. Fuel Cost	0.40 (\$/gal.)
3. Electrical Cost	0.03 (\$/kwh)
4. Maintenance Cost	0.03 (fract process cost)
5. Energy Credit	0.03 (\$/kwh)

The output from the SMART program gives the calculated values for the mass balances, the sizing, energy and emissions information, and finally the estimated capital and operating costs. A printout of the output information for the DFTP process is given in Table 4.

Lastly, output information for each of the unit processes for the whole treatment train of a sludge management alternative is summarized. An example is given for a sludge management process train that was considered in the early stage of LA/OMA's evaluation of sludge management alternative. A schematic flow diagram for the alternative is given in Fig. 2, with the heavier line indicating the specific path of that particular permutation. The Summary output is given in Table 5.

TABLE 4

SAMPLE OUTPUT INFORMATION FROM DIRECT FIRED
THERMAL PROCESSING SUBROUTINE

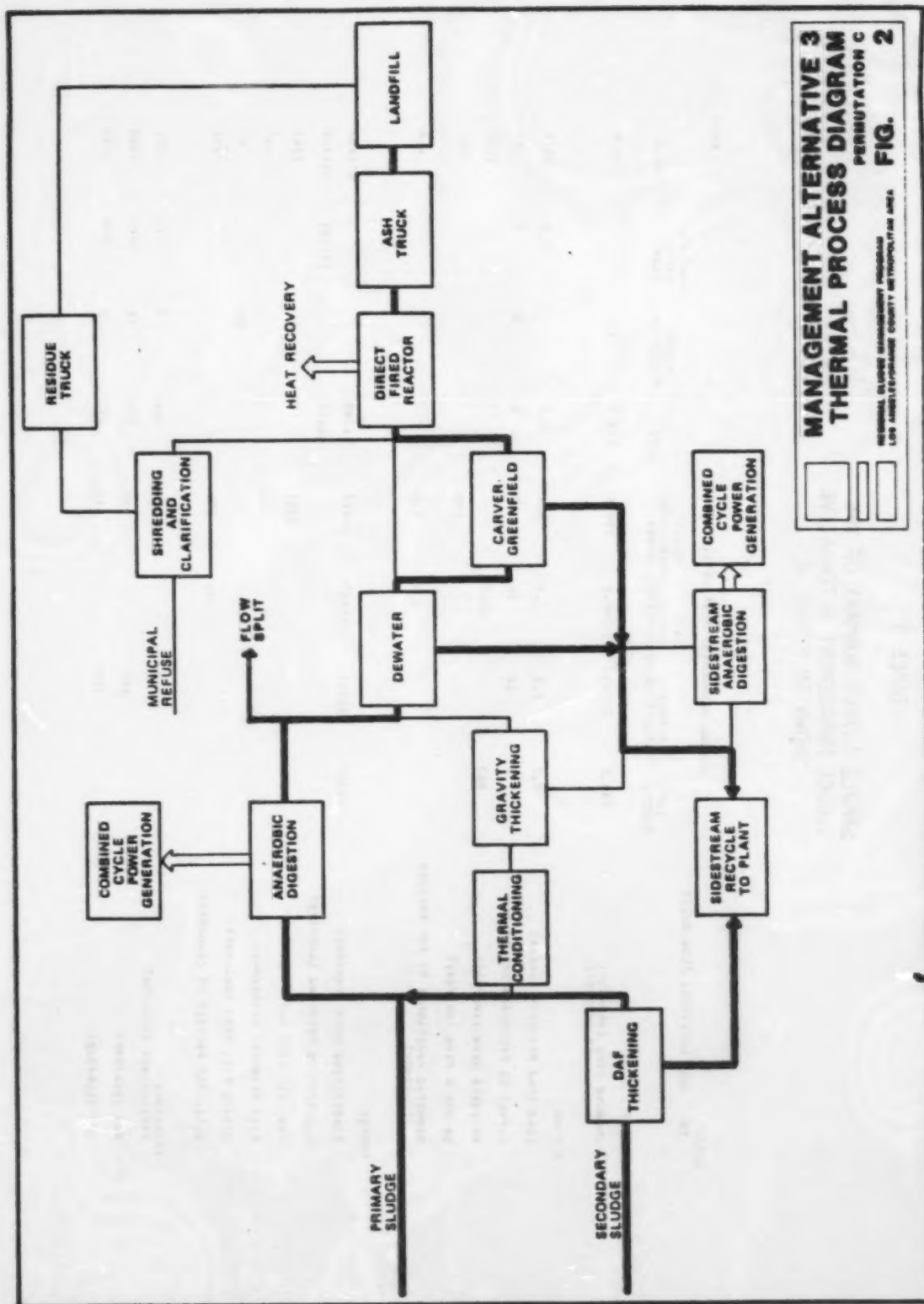
SIZING/ENERGY/EMISSIONS

LAND AREA	0.50 ACRES
BUILDING SIZE (5 LEVELS)	9528. SQ. FT.
NUMBER OF FURNACES AT 25 FT 9 IN X 12 HEARTH EACH	1
FUEL OIL	0.0 GAL/HR
RDF INPUT	0.0 TONS/DAY
ASH	73.8 TONS/DAY
ASH	99.4 CU. YDS./DAY
TEMP LEAVING AFTERBURNER	2870. DEGREES F
STEAM AT 600 PSIG AND 800 DEG. F	40483.1 LBS/HR
TURBINE POWER OUTPUT	4008.2 KW
ENERGY OUTPUT	96198. KWH/DAY
ELECTRICAL ENERGY USE	14080. KWH/DAY
STACK GAS	1046.3 TONS/DAY
PARTICULATE	188. LBS/DAY
NOX	590. LBS/DAY
SO2	240. LBS/DAY

CAPITAL COST

INPUT ENR		
LAND		3031.
PROCESS		3031.
STRUCTURAL		3031.
OUTPUT ENR		3031.
LAND CAPITAL COST	\$	0.
COST/ACRE	\$	0.00
PERCENT CONTINGENCY		0.20
ANNUAL LAND COST	\$	0.
AMORTIZATION RATE		0.06625
AMORTIZATION PERIOD		20. YEARS
CAPITAL RECOVERY FACTOR		0.09166

TOTAL PROCESS COST	\$	15932222.
PERCENT CONTINGENCY		0.35
TOTAL STRUCTURAL COST	\$	693225.
COST/SQ. FT.	\$	63.20
PERCENT CONTINGENCY		0.35
TOTAL PROCESS AND STRUCTURAL COST	\$	16625447.
ANNUAL PROCESS AND STRUCTURAL COST	\$	1523881.
AMORIZATION RATE		0.06625
AMORITZATION PERIOD		20. YEARS
CAPITAL RECOVERY FACTOR		0.09166
TOTAL ANNUAL CAPITAL COST	\$	1523881.
OPERATION AND MAINTENANCE COST		
LABOR	\$	216671.
COST/HR	\$	12.50
TOTAL MEN/24 HRS		5
PYROLYSER LABOR	\$	216671.
MEN/24 HRS		5
RDF LABOR	\$	0.
MEN/24 HRS		0
FUEL OIL	\$	0.
COST/GAL	\$	0.40
MAINTENANCE	\$	45716.
PERCENT OF PROCESS COST		0.33
ELECTRICAL	\$	154176.
COST/KWH	\$	0.0300
TOTAL ANNUAL O AND M COST	\$	416563.
ENERGY CREDIT	\$	1053363.
CREDIT/KWH	\$	0.0300
TOTAL OPERATING CREDIT	\$	1053363.
TOTAL ANNUAL OPERATING COST	\$	-636799.
TOTAL ANNUAL COST	\$	887082.
TOTAL ANNUAL COST PER DRY TON OF CCMBINED SLUDGE & RDF FEED	\$	13.63
TOTAL ANNUAL COST PER DRY TON OF FEED	\$	13.63



MANAGEMENT ALTERNATIVE 3
THERMAL PROCESS DIAGRAM
 PERMUTATION C
 FIG. 2

REGIONAL SLUDGE MANAGEMENT PROGRAM
 LOS ANGELES/DADE COUNTY METROPOLITAN AREA

TABLE 5

SAMPLE OUTPUT SUMMARY OF THE
SLUDGE MANAGEMENT ALTERNATIVE
SHOWN IN FIGURE 2

ACTIVITY	UNIT LOCATION; FLOW SPLIT	SLUDGE MANAGEMENT ALTERNATIVE 3C							PAGE 1
		DAF THICK.	ANAEROBIC DIGESTION	JELT PRESS DEMATERING	CANVER GREENFIELD DEMID.	OTTP	TRUCK TRANSPORT	COMBINED CYCLE PLANT	
Sizing									
	Loading (dry tons/day)	184.2	715.0	200.0	190.0	178.3	73.8	705.0	
	(0.0001 TONS/DAY)								
Sizing									
	Land Area Required (acres)	0.7	7.2	1.4	0.6	0.5	0.3	10.7	
	Number of Employees per 24 hrs	9	18	12	8	5	2	57	
	Polymers Used (lbs/day)	553		2000				2553	
	Isopar L Used (gal/day)				507			507	
	Required Additional O2 for Recycle (tons/day)			0.9	0.9			1.8	
Energy									
	Electricity Used (kwh/day)	18431	48641	11540	18810	14040		111492	
	Electricity Produced (kwh/day)					96198		447909	
	Fuel Oil Used (gal/day)				2361	0		2361	
	Fuel Produced (tons/day)				0.0			0.0	
	Diesel Fuel Used (gal/day)						89	89	
	Elec. for Recycle O2 (kwh/day)			296	279			575	
Emissions									
	Particulate (lbs/day)		17		141	188	3	388	
	NOx (lbs/day)		248		146	500	15	2045	
	SO2 (lbs/day)		319		312	340	2	1682	

ITEM	BY LOCATION: FLOW SPLIT	SLUDGE MANAGEMENT ALTERNATIVE AC							TOTAL
		DAP THICK.	ANACROBIC DIGESTION DEMATERING	PRESS GREENFIELD	CARVER DENTO.	DTTP	TRUCK TRANSPORT	COMBINED CYCLE PLANT	
COSTS									
Capital Cost									
Total Land Cost (\$000)		0	0	0	0	0	0	0	0
Total Process and Structures Cost (\$000)		13524	26735	7601	19048	16625	146	6266	89963
Total Capital Cost (\$000)		13524	26735	7601	19048	16625	146	6266	89963
Total Annual Capital Cost (\$000)		1240	2450	697	1748	1524	35	574	8268
Operations and Maintenance Cost									
Labor (\$000/yr)		390	780	520	347	217	87	130	2471
Diesel Fuel (\$000/yr)							13		13
Fuel Oil (\$000/yr)					345	0			345
Electricity (\$000/yr)		202	533	126	204	154			1221
Polymers (\$000/yr)		403		1460					1863
Isopar L (\$000/yr)					139				139
Maintenance (\$000/yr)		37	146	21	52	46	22	17	341
Recycle Oxygen (\$000/yr)				6	3				15
Dump Charge (\$000/yr)							67		67
Subtotal (\$000/yr)		1033	1459	3135	1086	417	189	147	6468
Credits									
Sale of Carver-Greenfield (\$000/yr)					0				0
Sale of Compost (\$000/yr)						-1053		-1553	-4804
Sale of Fuel (\$000/yr)									
Sale of Electricity (\$000/yr)									
Refuse Tipping Fee (\$000/yr)									
Refuse Resale (\$000/yr)									
Subtotal (\$000/yr)					0	-1053		-1553	-4804

3CTJ1 TREA NT LOCATION: FLOW SPLIT

SLUDGE MANAGEMENT ALTERNATIVE 3C

	DAF THICK.	ANAEROBIC DIGESTION	FRESH DEWATERING	LT GREENFIELD DEHYD.	CARVER	DFIP	TRUCK TRANSPORT	COMBINED CYCLE PLANT	TOTAL
TOTAL ANNUAL OPERATING COST (\$000/YR)	1032	1459	2135	1086		-637	189	-3704	1560
TOTAL ANNUAL CAPITAL AND OPERATING COSTS (\$000/YR)	2272	3910	2832	2834		887	223	-3130	9828
TOTAL ANNUAL COST/TON OF DRY FEED (\$/ton) (* -WET BASIS)	33.79	14.98	38.79	40.87		13.63	8.30		38.19

TEXT REFERENCES

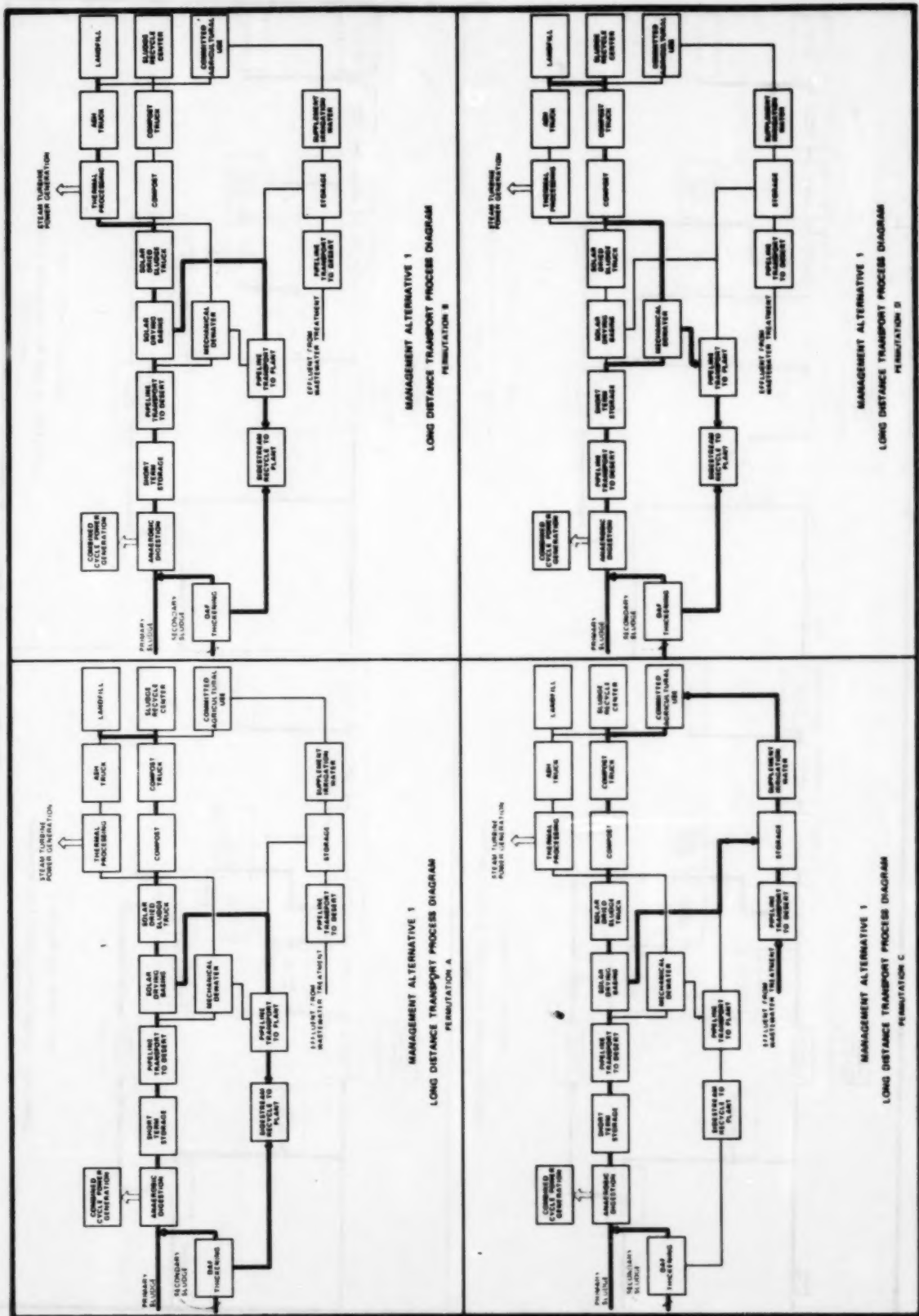
1. "SMART - Sludge Management Alternative Report Tool" User Guide Vol. 1 and 2, Report to LA/OMA Project, by CH2M-Hill. 1978.
2. Preliminary Computer Analysis of Sludge Management Alternatives - Unit Process Design, Cost, Energy, and Emission Factors, LA/OMA Project Task Report, by CH2M-Hill. 1978.

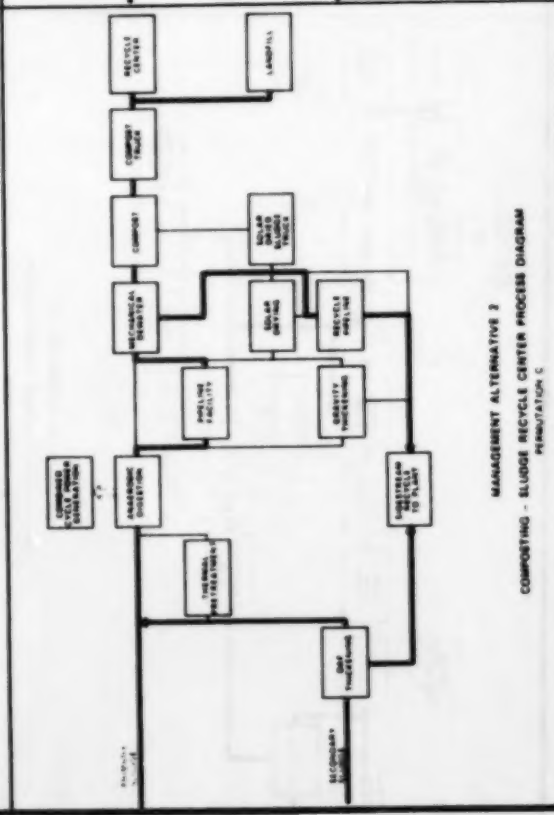
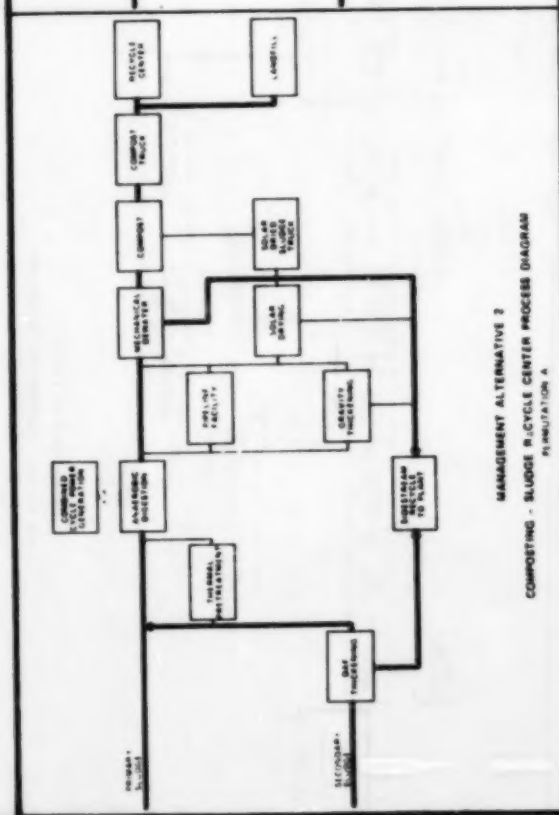
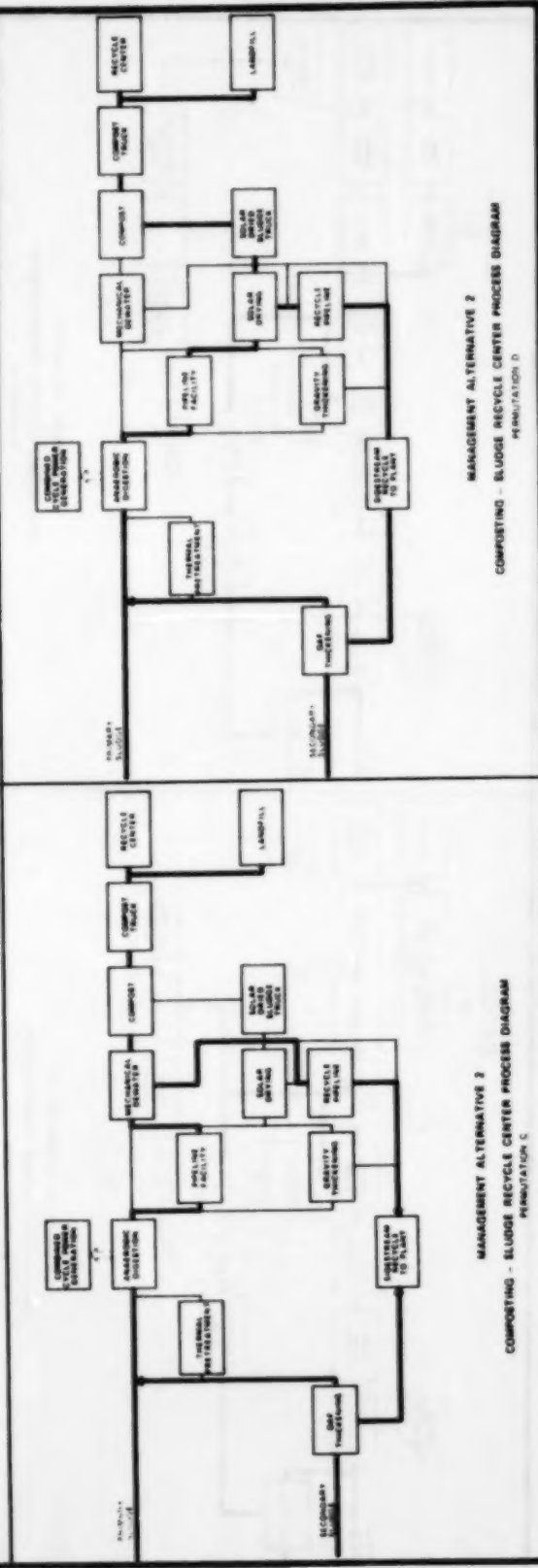
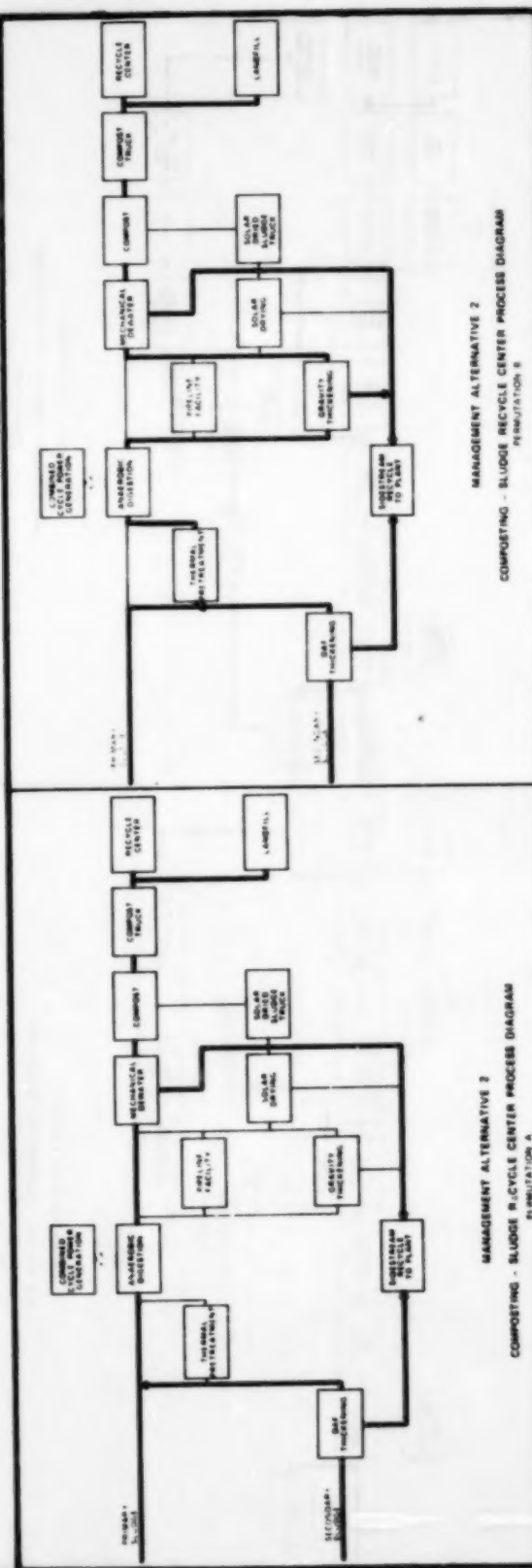
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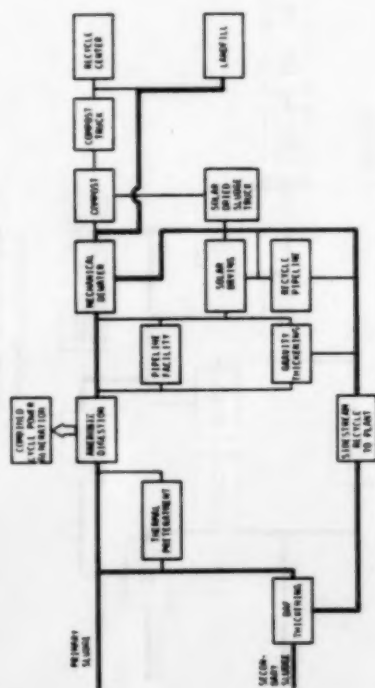
APPENDIX C

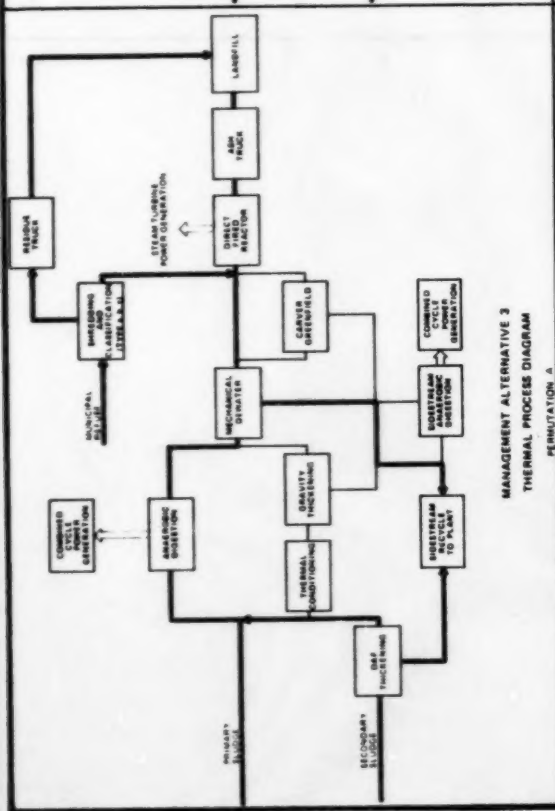
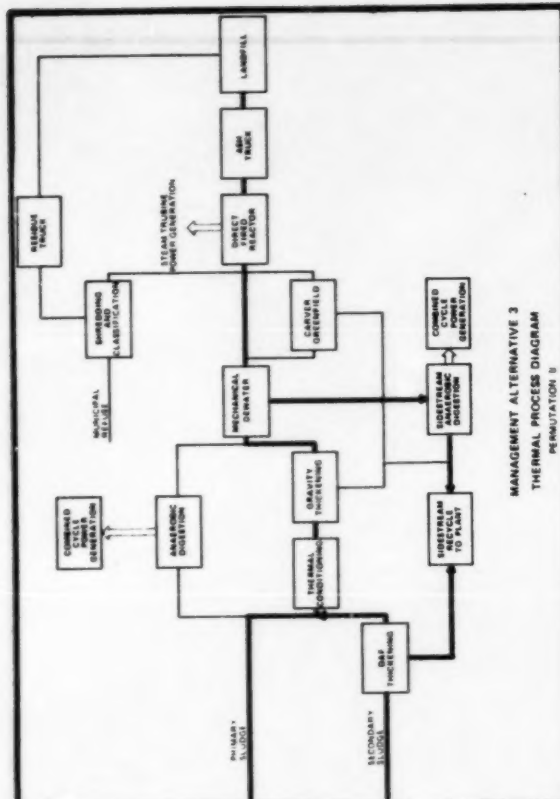
PROCESS FLOW DIAGRAMS FUNDAMENTAL SLUDGE MANAGEMENT ALTERNATIVES

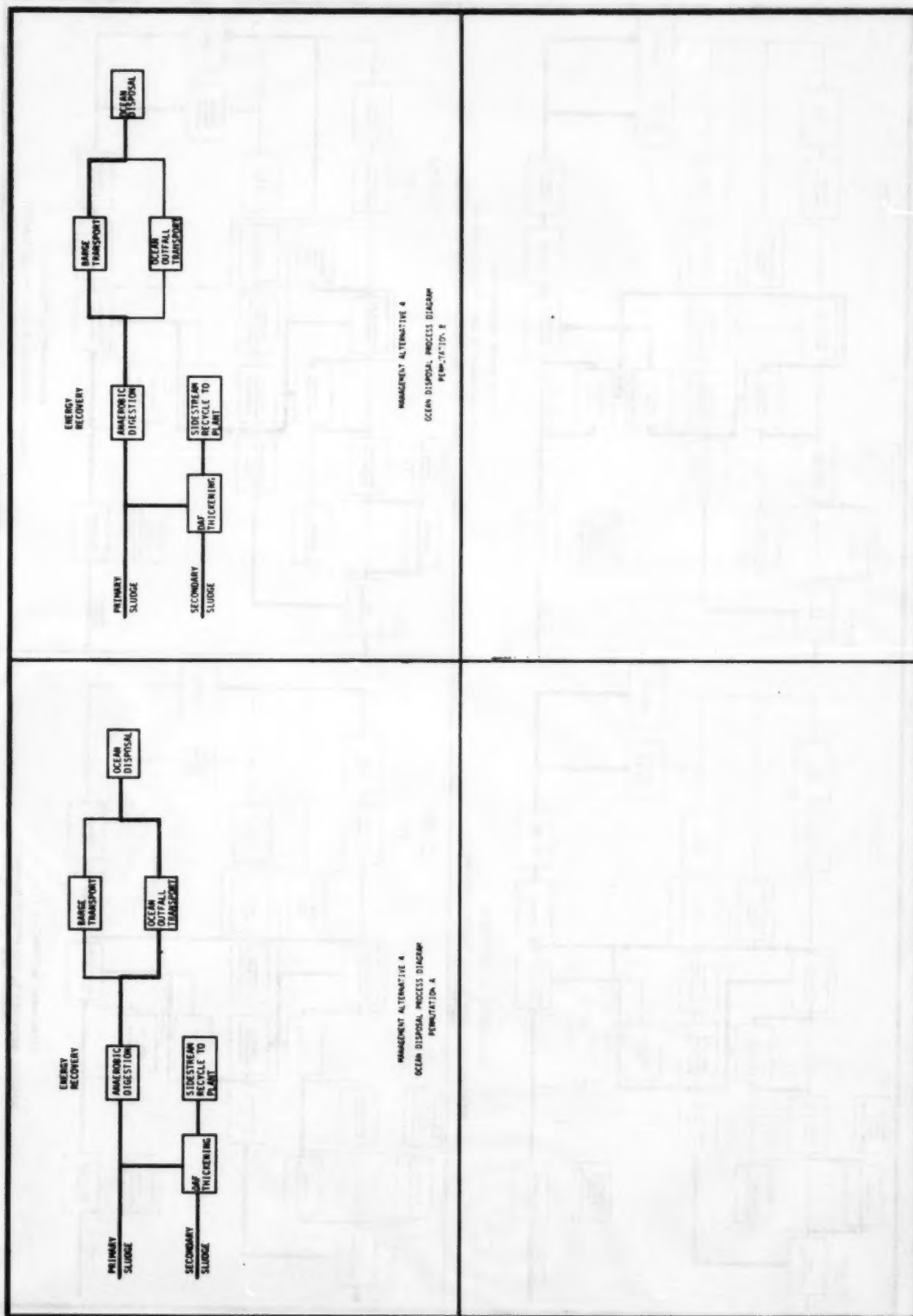
Process flow diagrams for each of the six Sludge Management Alternatives (SMA's) and their permutations are presented in this appendix. The Sludge Management Alternatives were developed based on results of the analysis of initial Candidate Systems. Analysis of the SMA's, coupled with information from site investigation studies, demonstration projects, and other technical studies, led to formulation of the Alternative Sludge Management Projects described in Chapter III.

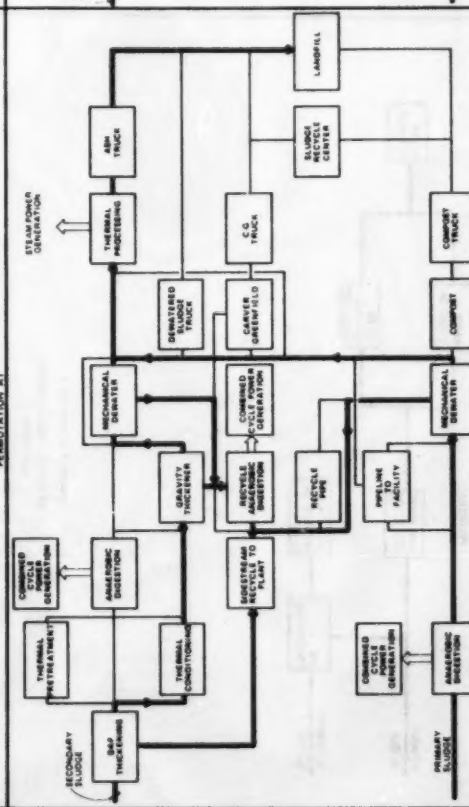
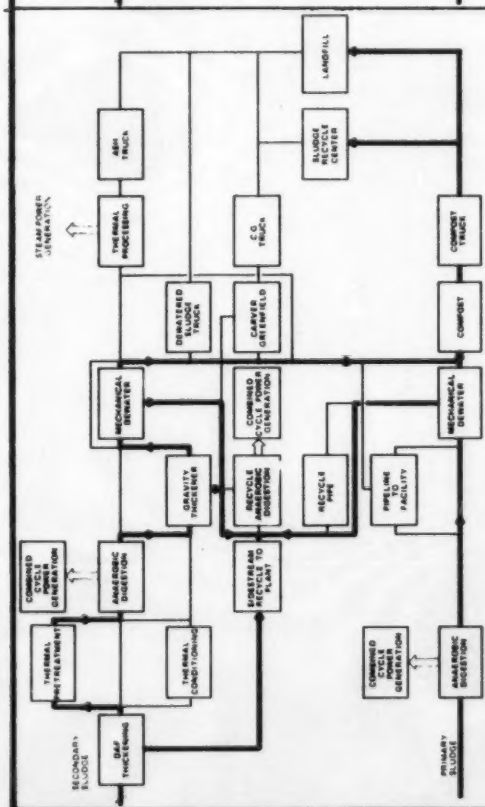
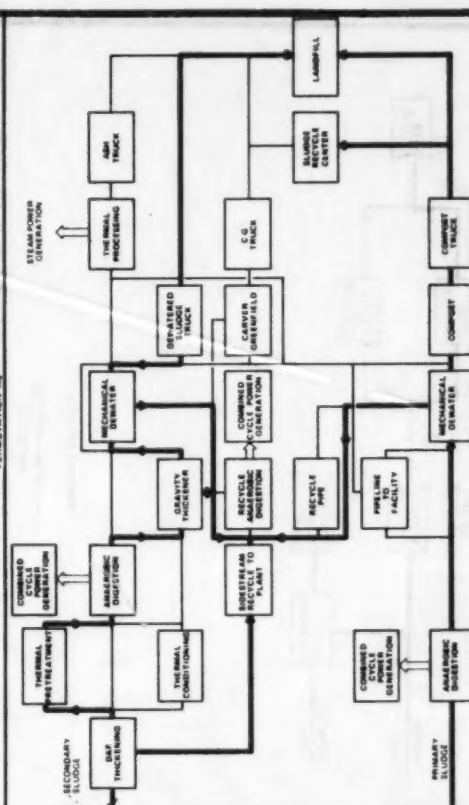
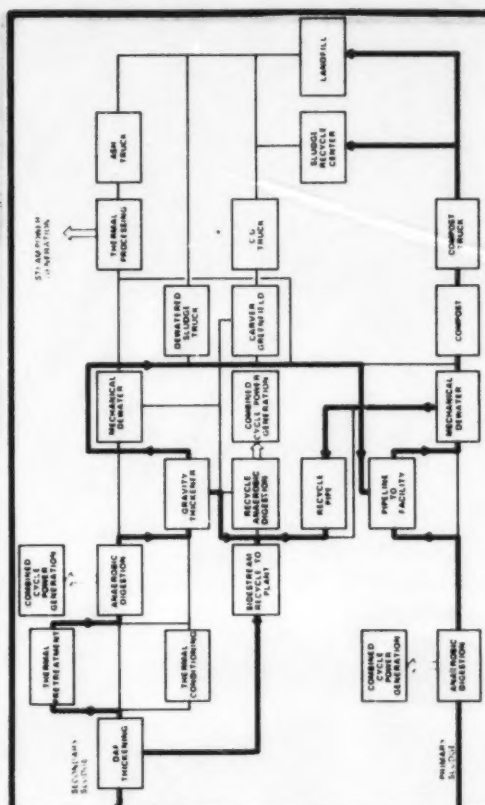


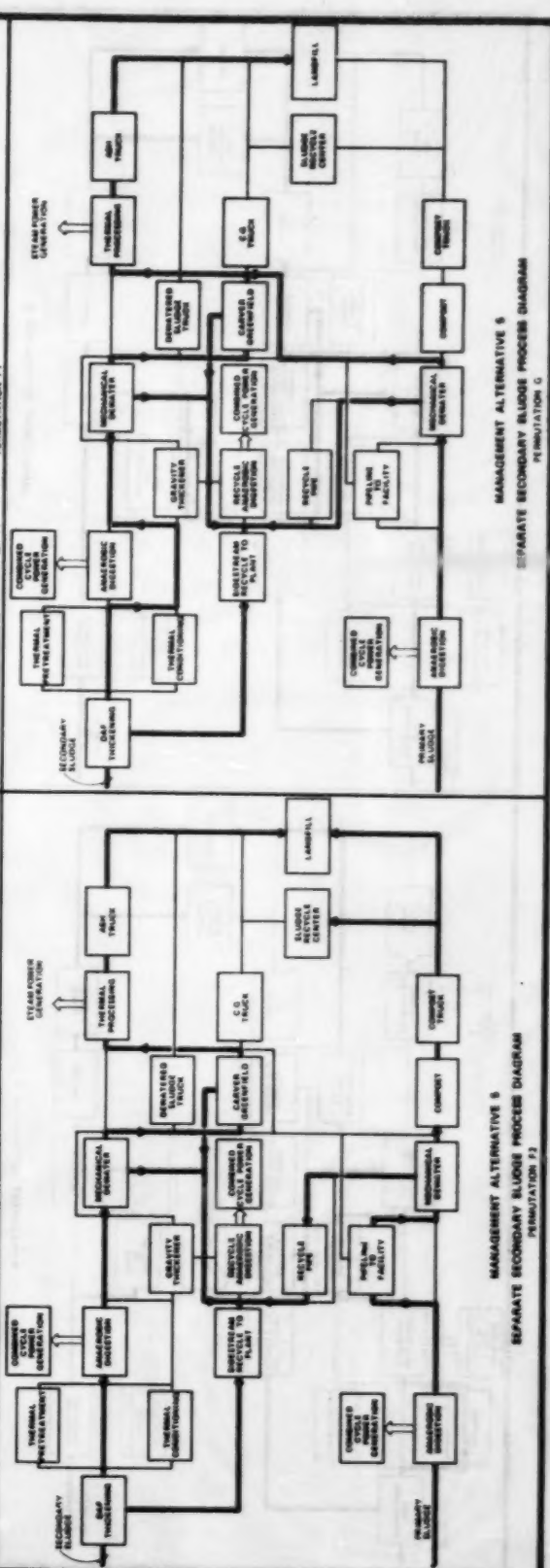
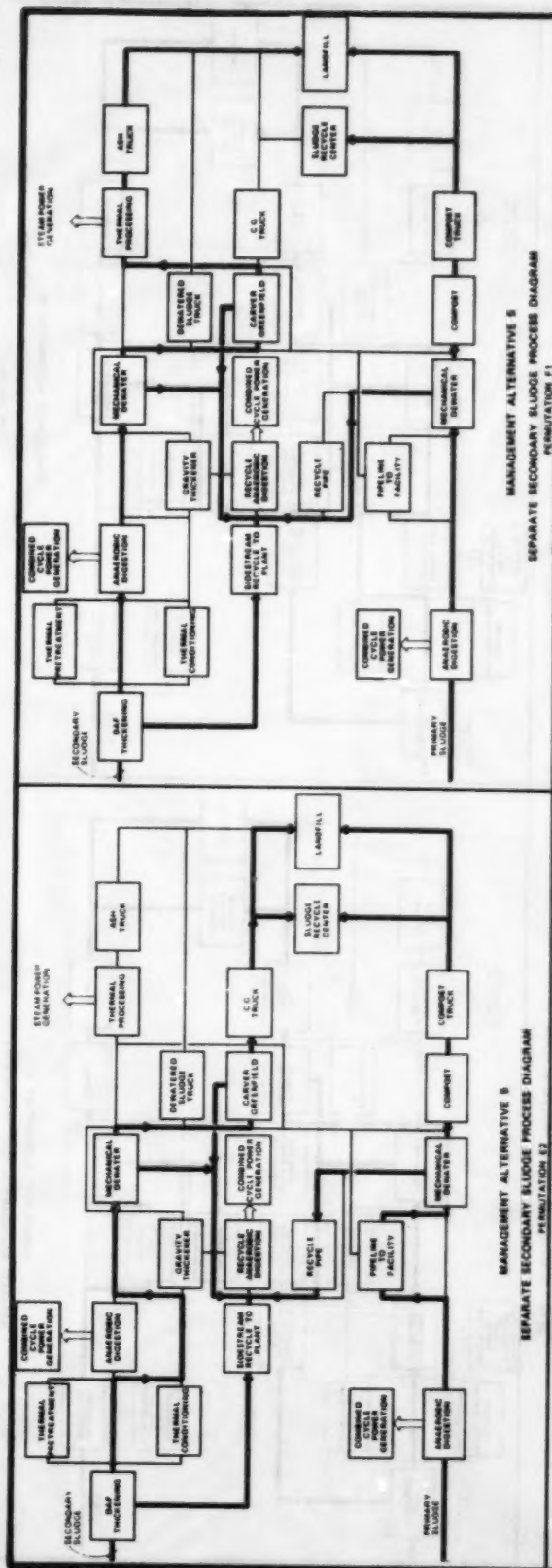


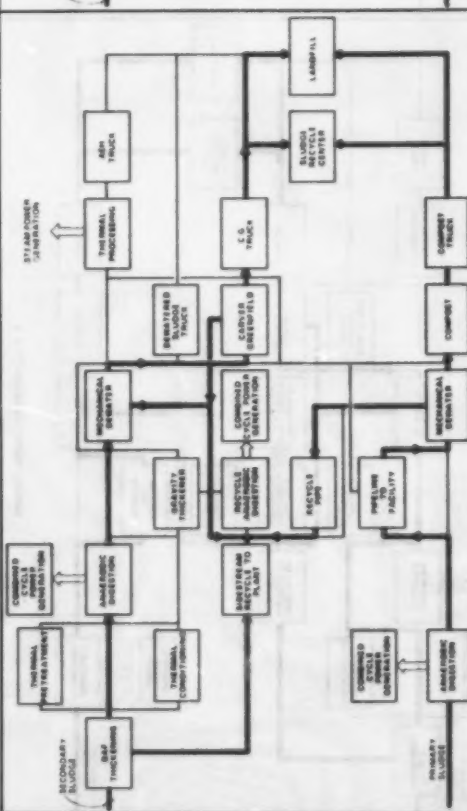
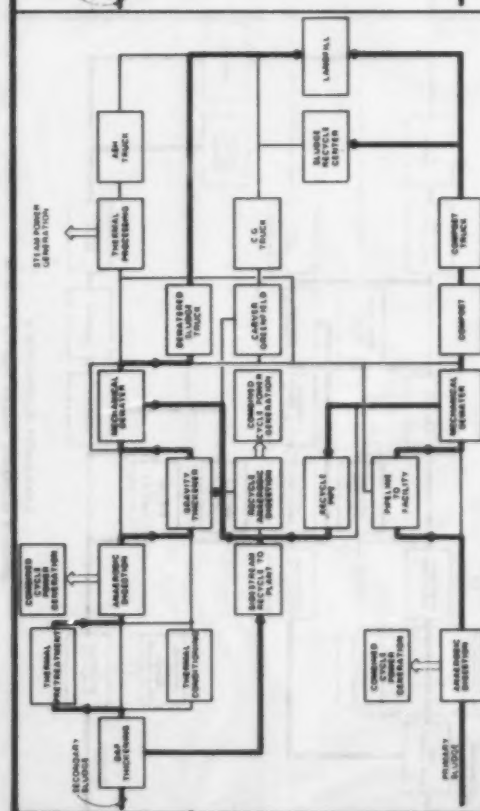
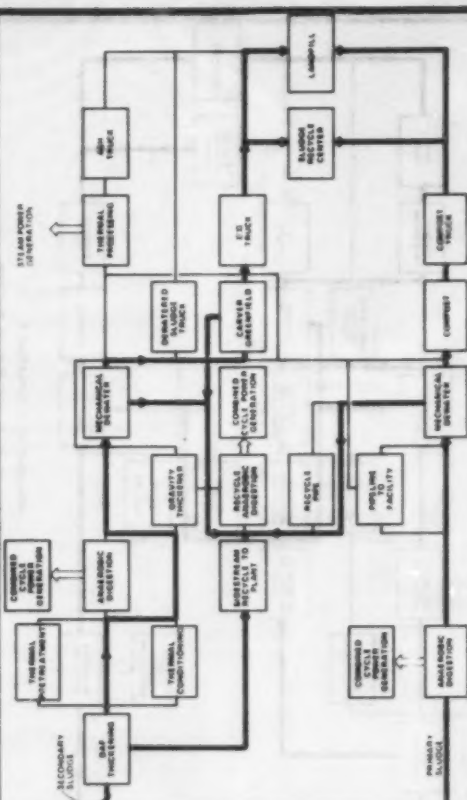
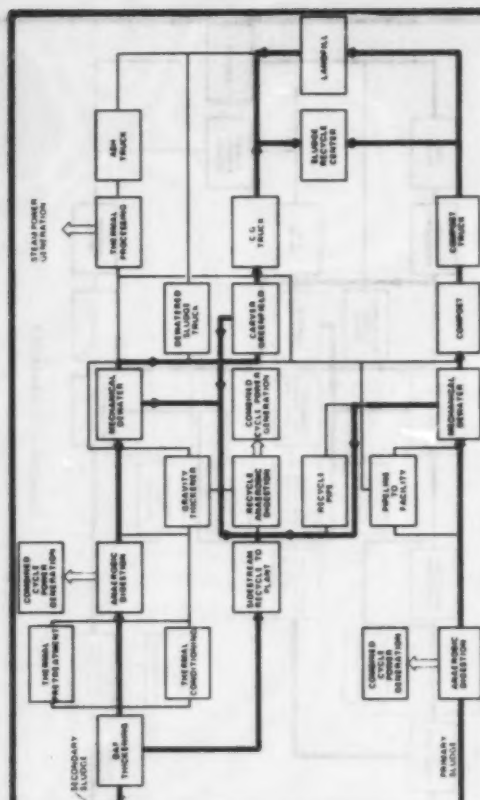


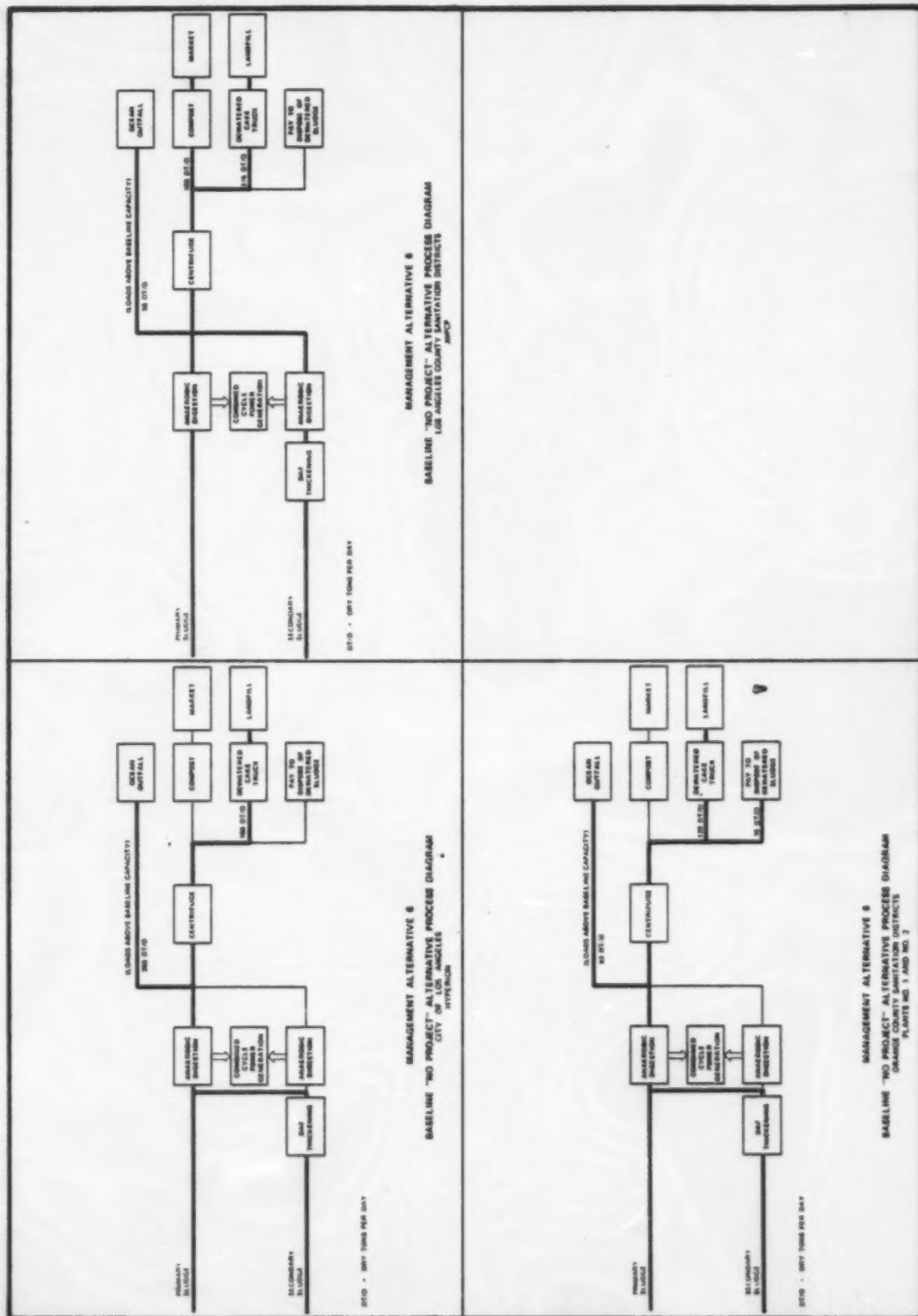












CONTRACTS

C-12

**LIST OF CONSULTANT CONTRACTS
AS REQUIRED BY CALIFORNIA GOVERNMENT CODE SECTION 7800**

Number ⁽¹⁾	Amount	Consultant	Subcontractors To Consultant Subcontractor	Amount ⁽²⁾	Scope of Services
2218	\$ 274,288	University of California at Riverside			3 1/2 year field study of soil and crop response to sludge applications, 1 year greenhouse study of crop response to various metals loadings.
2241	153,500	CH ₂ M H111			Initial analysis of eighteen candidate systems for sludge processing, transportation, reuse and disposal. Preliminary site inventory to identify alternative project areas.
2275	65,000	Gruen Gruen & Associates			Analysis of existing and past sludge marketing experiences and development of marketing strategies for LA/QMA area.
2280	30,000	CH ₂ M H111			Development of unit process design, cost energy and emission factors.
2282	45,000	Southern California Coastal Water Research Project			Review of existing data; description of existing conditions around LA/QMA ocean outfalls; forecast effects under the Base-line No-Project alternative; summarize information on other dischargers; collection of additional data.
			LeRoy Crandall & Associates	\$ 6,067	Geohydrological evaluations
			L.J. Sziljj, Ph.D., N. Hogg	7,598	Ecological evaluations
2287	63,000	Daniel, Mann, Johnson, & Mendenhall			Regional environmental evaluation of alternative project areas to identify potentially suitable sites for alternative sludge management projects.
2290	41,000 ⁽³⁾	California Institute of Technology			Assessment of alternative strategies for sludge disposal into deep basins off Southern California.
2291	18,000 ⁽³⁾	Southern California Coastal Water Research Project			Measurements and information on currents and marine life in deep ocean basins off Southern California.
2292	201,352	CH ₂ M H111			Development of digital computer program for analysis of alternative sludge management projects; screening of permutations of alternatives to identify most viable unit process train for each alternative; screening of potentially suitable sites for engineering constraints; qualitative engineering evaluation of alternative sludge management projects; operation of computer program for each alternative project.
2295	118,000	Daniel, Mann, Johnson & Mendenhall			Environmental assessment of ten alternative sludge management projects.
			LeRoy Crandall & Associates	11,000	Geohydrological evaluations
			Bolt Beranek & Newman	2,650	Consultation on air quality and public health assessment
			Laszlo Sziljj, Ph.D.	4,500	Ecological evaluations
			R.A. Mah, Ph.D.; J. Valentine, Ph.D.	800	Consultation on public health assessment

LIST OF CONSULTANT CONTRACTS
AS REQUIRED BY CALIFORNIA GOVERNMENT CODE SECTION 7800 (CONTD.)

Number	Amount	Consultant	Subcontractors To Consultant Subcontractor	Amount (2)	Scope of Services
2382	\$ 77,000	Daniel, Mann, Johnson, & Mendenhall			Environmental assessment of proposed sludge management program and preparation of draft environmental impact statement/report
			Bolt Beranek & Newman	\$ 1,450	Consultation on air quality evaluation
			Environmental Research Archaeologists	1,800	Archaeological field survey
			Environmental Resources Group	8,700	Evaluation of impacts on public services and facilities, and economics
			Linda F. McCaffery	2,400	Staff assistance in finalizing draft environmental impact statement/report
48854	7,500	Clement Mesavage Jr.			Evaluation of feasibility for sludge exportation to foreign countries
59532	9,800	John R. Calaprice, Ph.D.			Review data and reports by SCCRP on conditions in the ocean around existing outfalls; prepare summary of such reports suitable for draft environmental impact statement/report; assist in development of marine aspects of LA/DMA's comparative evaluation process.
63990	6,500	Daniel, Mann, Johnson, & Mendenhall			Identification of potentially viable offsets not included in the air quality management plan including costs of such offsets
64390	5,000	BSP Division, Enviro- tech Corporation	Bolt Beranek & Newman	2,700	Air emission trade off analysis including additional control systems
64433	9,999	BSP Division, Enviro- tech Corporation			Laboratory testing of pyrolysis of dried sludge to develop engineering design parameters for thermal processing
66868	9,950	John R. Calaprice, Ph.D.			Laboratory testing of pyrolysis of dried sludge to confirm or develop air emission factors to be used in analyses of thermal processing
72451	5,000	John R. Calaprice, Ph.D.			Expansion of summary report on marine biological effects under the Baseline No-Project alternative to incorporate new information developed by participating agencies; to reflect projected effects of industrial pretreatment.
73813	8,000	John R. Calaprice, Ph.D.			Review of comments on final draft of summary report and revision of report as necessary and appropriate to reflect comments received.
78613	6,100	Daniel, Mann, Johnson, & Mendenhall			Continuing technical assistance in preparation of draft environmental impact statement/report including review of sections of effects of ocean disposal on marine geological resources and responses to technical issues raised during course of preparation and review of the draft environmental statement/report
					Additions to assessment of proposed sludge management program

- (1) Contract or purchase order number.
(2) Included in total contract amount.
(3) Local operating agency funds. No federal or state funds involved.